Illicit Nuclear Trafficking: Collective Experience and the Way Forward

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Edinburgh, 19–22 November 2007

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ILLICIT NUCLEAR TRAFFICKING: COLLECTIVE EXPERIENCE AND THE WAY FORWARD

PROCEEDINGS SERIES

ILLICIT NUCLEAR TRAFFICKING: COLLECTIVE EXPERIENCE AND THE WAY FORWARD

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FOREWORD

Considerable concern over the illicit trafficking of nuclear material began in the early 1990s following a number of incidents involving the seizure of high enriched uranium. After 11 September 2001, there has been growing government and public concern that nuclear and other radioactive material may fall into the hands of terrorists or criminals who could use it for malicious purposes.

States have increasingly recognized their responsibility to control unauthorized movement of radioactive material. Efforts are being made to secure national borders through the installation of radiation detection equipment and to ensure that frontline officers have adequate training and support to deal with and respond to seizures and detection alarms. During recent years, dramatic improvements have been seen in equipment and methodologies used for detecting and characterizing illicitly trafficked material. In addition, more attention has been focused on increasing the security of transport of nuclear and other radioactive material.

The IAEA, through the Nuclear Security Plan for 2006–2009, established an overarching goal to contribute to strengthened nuclear security worldwide, and a wide range of bilateral and multilateral initiatives aim at preventing the illegal movement of radioactive material that could be used by non-State actors for malicious purposes.

In concert with those actions, the international community has taken important steps to strengthen the platform of international instruments of relevance for nuclear security. These instruments contain obligations of direct relevance for combating illicit nuclear trafficking.

With all of this in mind, the IAEA felt that it was timely to convene the first international conference to specifically address illicit trafficking of nuclear and radioactive materials. The principal aim of the conference was to examine the threat and context of illicit nuclear trafficking of radioactive material: what is being done to combat such trafficking and where more needs to be done, particularly how the obligations and commitments of the binding and non-binding international instruments could be and are being implemented by various States.

The Conference was organized by the IAEA and hosted by the Government of the United Kingdom in cooperation with INTERPOL, Europol and the World Customs Organization (WCO). Attendance by approximately 300 participants from some 60 States and 11 international organizations was testimony to the widespread recognition of the importance of the issue. Eighty oral presentations were given in eight sessions. These oral presentations were supplemented by 20 posters and the exhibition of state of the art equipment by 15 commercial exhibitors.

These proceedings constitute a record of the Conference and include a summary, the papers presented orally and as posters, and the findings of the Conference by the President, as well as a record of the discussions. The attached CD-ROM contains the presentations of most of the papers presented orally, as well as the complete text of the printed volume.

The IAEA gratefully acknowledges the support and generous hospitality provided by the Government of the United Kingdom.

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SUMMARY

SUMMARY

1. BACKGROUND

Considerable concern over the illicit trafficking of nuclear material began in the early 1990s following a number of incidents involving the seizure of high enriched uranium. After the terrorist attacks of 11 September 2001, there was growing government and public concern that nuclear and other radioactive material may fall into the hands of terrorists or criminals who could use it for malicious purposes. This Conference examined the threat and context of illicit nuclear trafficking of radioactive material: what is being done to combat such trafficking and where more needs to be done.

States have increasingly recognized their responsibility to control unauthorized movement of radioactive material. Efforts are being made to secure national borders through the installation of radiation detection equipment and to ensure that frontline officers have adequate training and support to deal with and respond to seizures and detection alarms. During recent years, dramatic improvements have been seen in equipment and methodologies used for detecting and characterizing illicitly trafficked material. In addition, more attention has been focused on increasing the security of transport of nuclear and other radioactive material.

The IAEA, through the Nuclear Security Plan for 2006–2009, established an overarching goal to contribute to strengthened nuclear security worldwide. The Plan builds on recent achievements in strengthening the international legal instruments that are relevant to nuclear security. A key function of the Plan is to establish an internationally accepted *nuclear security framework* of recommendations and guides, including for the detection of and response to thefts and losses, unlawful possession and trafficking, illegal disposal, and criminal and unauthorized use of nuclear and other radioactive materials. International consensus guidance documents are disseminated through a new IAEA Nuclear Security Series of publications. The Plan further provides for activities that include assessment and evaluation services, technical advice, human resource development programmes and — to a limited extent — needed technical equipment.

Additionally, a wide range of bilateral and multilateral initiatives to combat illicit trafficking are being implemented. These include security of radioactive material cargo shipped around the world and enhanced port security to minimize the risk of radioactive material being illegally transported from State to State. These initiatives aim at detecting any transport containing nuclear weapons of mass destruction (WMD) and are designed to contribute to preventing the illegal movement of radioactive material that could be used by non-State actors for malicious purposes.

At the same time, the international community has taken important steps to strengthen the platform of international instruments of relevance for nuclear security. These instruments contain obligations of direct relevance for combating illicit nuclear trafficking.

With all of these activities in mind, the IAEA felt that it was timely to convene the first international conference to specifically address illicit trafficking of nuclear and radioactive material to take stock of achievements in recent years, challenges in addressing the need to combat illicit nuclear trafficking, and avenues for future action. Particular attention was paid to where further actions of individual States and cooperative international actions might usefully be initiated. The Conference participants also looked at how these obligations and political commitments under the binding and non-binding international instruments could be and are being implemented by various States.

The Conference concluded that illicit nuclear trafficking remains an international concern, with potential for serious consequences for human life, health, property and the environment; and that efforts must continue to establish effective systems, technical and administrative, to control movement of nuclear and other radioactive materials, and to prevent and detect their uncontrolled and unauthorized movement.

The Conference was hosted by the Government of the United Kingdom and organized by the IAEA in cooperation with INTERPOL, Europol and the World Customs Organization (WCO). Attendance by approximately 300 participants from some 60 States and 11 international organizations was testimony to the widespread recognition of the importance of the issue. Over eight sessions, 80 oral presentations were given. These oral presentations were supplemented by 20 posters and the exhibition of state of the art equipment by 15 commercial exhibitors.

2. MAIN OUTCOMES OF THE CONFERENCE

2.1. Illicit trafficking and nuclear terrorism

It was felt that the IAEA Illicit Trafficking Database (ITDB) provides evidence of persistent illicit nuclear trafficking, thefts and losses, and other unauthorized activities involving nuclear and other radioactive materials in addition to valuable information both on such attempts and on weaknesses and vulnerabilities which may be exploited to acquire the material. There was wide agreement among the conference participants on the value of the ITDB and encouragement for further expansion of the comprehensiveness and quality of the information, and its analysis with a view to further enhancing understanding of illicit nuclear trafficking. The Conference identified a need to distinguish better between ‘trivial events’ and significant events as a way of improving the analytical work based on the data being collected.

Conference papers and the discussions provided that terrorist groups have the intention of attempting to acquire and use nuclear or radioactive material for malicious acts and that the possibility of such actions is real.

Further, the participants agreed that it should be a global priority to stop the illicit movement of nuclear material, equipment and technologies that could be used for malicious purposes. Since the human, political and economic consequences of a successful malicious act involving nuclear or other radioactive materials could be far reaching, the limited knowledge of direct attempts to acquire such material is no cause for comfort. The Conference recognized that a holistic approach, addressing both detection and prevention, is essential.

2.2. International binding and non-binding instruments and their implementation

The Conference discussed the emergence of new and amended international instruments related to nuclear security, which require States to strengthen measures to combat illicit trafficking. The provisions of these instruments, some binding, some voluntary, amount to a significant strengthening of the legal and guidance framework existing prior to 2001. The framework includes IAEA safeguards agreements and their additional protocols, inasmuch as these require accounting and control of nuclear material and the establishment of State systems of accounting and control.

The Conference identified a need to continue building the institutional framework that is necessary to implement these legal instruments, in particular, by establishing the required technical and administrative systems for illicit nuclear trafficking, and felt that the IAEA can play a useful role.

It was recognized that universal adherence to the amendment to the Convention on the Physical Protection of Nuclear Material (CPPNM) and other international legal instruments can make a major contribution to enhancing nuclear security and combating illicit trafficking, including better cooperation and coordination in implementing the reporting obligations contained in the Early Notification and Assistance Conventions. Conference participants particularly suggested that consideration be given to strengthening legally binding obligations in relation to the safety and security of radioactive sources.

2.3. International and regional cooperation

The Conference heard of the contribution made by initiatives such as the Global Initiative on Combating Nuclear Terrorism and the European Union Strategy against the Spread of Weapons of Mass Destruction, as well as by organizations such as Europol, INTERPOL, WCO, the International Civil Aviation Organization (ICAO) and the United Nations Office on Drugs and Crime (UNODC). These were identified as positive developments in cooperation between these organizations and the IAEA, and further efforts in this direction were encouraged.

It was felt that international cooperation is essential for the understanding of trafficking circumstances, patterns and trends, and that continued efforts are required to strengthen existing networks, such as the IAEA ITDB point of contact system. A number of papers described the recent progress in the development of radiation detection instruments, and that international interaction, including through coordinated research and development, has contributed significantly to those achievements. The conference participants encouraged continued and strengthened mechanisms to facilitate development of new technologies and strategies, in particular, for the detection of fissile materials, including the private sector which can play an important role. There were a number of papers that noted some encouraging developments in the benefits that can accrue from strengthening cooperation at the regional level, especially in the areas of detection and response.

The Conference heard of significant advances in nuclear forensics technologies which can be used to trace and preserve evidence related to seized radioactive materials and hopes that these capabilities would be put at the disposal of States that do not have access to them and that more would be done to help the field of nuclear forensics to achieve its full potential.

2.4. National efforts to establish detection and interdiction capabilities

A number of papers described efforts that have been made to secure national borders through the installation of radiation detection equipment and to ensure that law enforcement officers have adequate training, skills and support to detect unauthorized radioactive materials and to respond to seizures and detection alarms. Recent years have seen dramatic improvements in equipment and methodologies for detecting and characterizing illicitly trafficked material.

In addition, many States reported on their national efforts to enhance measures to combat illicit trafficking, demonstrating a widespread awareness of the problem. There were indications of enhanced cooperation within States between relevant organizations with responsibilities for different aspects of combating illicit trafficking. However, there were also indications of significant disparities between capabilities in different States, which pointed to the need for some States to continue to receive assistance from donors.

The Conference noted that there was a need for increased sophistication in strategies for deploying and implementing detection capabilities which take into account all aspects of the risk, including that posed by unguarded borders. In particular, the hosting of major public events would call for assurance that radioactive material could not be used in a malicious way to disrupt the event.

The Conference emphasized the importance of States developing strategies to ensure the sustainability of national prevention and detection systems, and their scientific and technical support. In that respect, it recognized the function of nuclear security support centres.

The Conference recognized the importance of formulating effective communication strategies to avoid adverse public reactions to nuclear or radiological incidents.

2.5. Role of the IAEA

The Conference acknowledged the important achievements of the IAEA nuclear security programme. Among those considered of particular value were the development of an internationally accepted nuclear security framework, in which the IAEA Nuclear Security Series of publications would complement the binding and non-binding international instruments with recommendations and guidance on their implementation.

The Conference observed that there is a possible role for the IAEA in encouraging better reporting and coordination based on requirements contained in various relevant conventions, as well as the exchange of information and the need for effective analytical capacities and strengthened interaction between international organizations.

The Conference welcomed IAEA services and assistance, for example, with the assessment and evaluation of existing systems, technical advice related to improvements, human resource development programmes and — to a limited extent — the technical equipment that is required for improved security. The Conference also welcomed efforts to make available nuclear security support centres.

The Conference recognized with appreciation the contribution made by bilateral assistance programmes in the establishment of technical systems to prevent and detect unauthorized movement of nuclear and other radioactive materials. It noted the effective coordination by the IAEA to ensure complementary and efficient use of resources, and recognized that IAEA Integrated Nuclear Security Support Plans, as established for individual countries, could be a useful tool for that purpose.

The Conference recognized the value of having the IAEA play a role in promoting and coordinating research and development in the field of detection and response to illicit nuclear trafficking as part of effective nuclear security systems.

OPENING SESSION

OPENING ADDRESS

P. Jenkins
President

It gives me great pleasure to welcome you all to the historic city of Edinburgh and to this important conference.

Edinburgh has been the capital of Scotland since 1437. In the eighteenth century, it produced two of Europe's most influential thinkers: David Hume, whose scepticism left a deep mark on Western philosophy, and Adam Smith, whose *Wealth of Nations* can be seen as lying at the root of modern economic theory. The vigour and vitality of intellectual life in Edinburgh was then such that Edinburgh became known as the Athens of the North. We can hope that much of the spirit of that age has survived the intervening years and percolates into the proceedings of this conference!

The eighteenth century also saw the construction of the area known as the New Town. Its elegant streets and squares give expression to the enlightenment of that age. I hope you will have time to enjoy it in the course of this week — as well as the older part of the city stretching along the ridge crowned by Edinburgh's medieval castle, and all the other attractions of a city which is Britain's second most frequented tourist destination.

This conference, which the IAEA Secretariat has organized with its customary efficiency and which the United Kingdom Government is generously hosting, offers an opportunity for a comprehensive review of all aspects of illicit trafficking of nuclear and other radioactive materials. This is the first such opportunity since 2001 when heart wrenching events caused a step change in perceptions of the terrorist threat to human security and economic prosperity.

Nuclear terrorism has been recognized as a potential threat to human security and economic prosperity since at least the 1970s. Evidence of Al Qaeda's interest in acquiring nuclear material came to light during the 1990s. However, it is since the attacks of 11 September 2001 that the risk of nuclear terrorist acts has come to be a widespread public and governmental concern, for understandable reasons, and that efforts to combat illicit trafficking, which could lead to nuclear or other radioactive materials falling into the hands of terrorists, have intensified. Six years on, it makes sense to take stock of what has been achieved in the combat to stem illicit trafficking and of where further actions — actions of individual States and cooperative international actions — might usefully be initiated. That this has been recognized seems to me evident from the number of participants in this conference: over 300 from more than 60 countries.

The IAEA has maintained an Illicit Trafficking Database since 1995. Information reported to this database confirms that concerns about illicit trafficking in nuclear material are justified. For example, several instances of trafficking in HEU have come to light. In one of the most recent of these cases, 79.5 g of HEU were seized in the capital of Georgia. The material was enriched to 89.3%. The traffickers were caught attempting to sell this material.

Database information also points to persistent theft and loss of radioactive sources. The recovery rate of stolen or lost radioactive sources has been poor. The possibility that some of this radioactive source material is being trafficked cannot be excluded.

Meanwhile, this decade has seen further indications of terrorist interest in obtaining nuclear material. Though, as far as I know, there is as yet no evidence of terrorists actually acquiring nuclear or radioactive materials from traffickers, it would be logical for terrorists to use illicit trafficking as a means of supply. Needless to say, the consequences of successful terrorist acquisition of nuclear or other radioactive material could be devastating. Thus, denying terrorists this option by bringing to an end the illegal movement of nuclear and other radioactive materials, and also of equipment and technologies that could be conducive to terrorist acts, has become a global priority. That is why this conference is so important.

It is also necessary to recall that the years since 2001 have seen some significant changes in States' international obligations relevant to international nuclear trafficking. It may be helpful if, at the outset, I spell out what these are.

The Convention on the Physical Protection of Nuclear Material (CPPNM), which entered into force in 1987, provides for specified minimum levels of physical protection during international (underlined) transport of nuclear material and establishes a general framework for cooperation among States in the protection, recovery and return of stolen nuclear material. The Amendment to the CPPNM signed in July 2005 will, when in force, make it legally binding for State parties to establish and maintain a physical protection regime to protect nuclear material and facilities in peaceful domestic (underlined) use, storage and transport. It will also provide for expanded cooperation between and among States regarding rapid measures to locate and recover stolen or trafficked nuclear material, to mitigate or minimize any radiological consequences of sabotage and to combat related offences.

The International Convention for the Suppression of Acts of Nuclear Terrorism, which entered into force on 7 July 2007, details offences, including but not limited to those relating to unlawful possession and use of radioactive material or devices, and to damage of nuclear facilities in a manner which causes the release or risks the release of radioactive material. State parties are required to adopt measures as necessary to criminalize these and other offences. It also requires State parties to make every effort to adopt appropriate measures to ensure the protection of radioactive material. Further, it requires States to undertake certain measures, including physical protection, with regard to the disposition of any radioactive material, devices or nuclear facilities seized or for which a State takes control, following the commission of an offence under the Convention.

United Nations Security Council Resolution 1540, adopted under Chapter VII of the United Nations Charter in 2004, deals with weapons of mass destruction, including nuclear weapons and non-State actors. The resolution obliges all States to adopt and enforce appropriate effective laws which prohibit the manufacture, acquisition, possession, development, transport, transfer or use of nuclear weapons by non-State actors, in particular for terrorist purposes. It also obliges States to establish domestic controls to prevent the proliferation of nuclear weapons, including the establishment of appropriate controls over related materials. To this end, States are obliged to implement a variety of accountancy and control measures; physical protection measures; border controls; measures to detect, deter, prevent and combat illicit trafficking; and import and export control measures.

United Nations Security Council Resolution 1373 adopted in 2001, among other things, requires all States to take the necessary steps to prevent the commission of terrorist acts, including early warning to other States.

In addition to these legally binding instruments, there is the non-binding Code of Conduct on the Safety and Security of Radioactive Sources, which Member States of the IAEA agreed in 2003. The Code's objective is to achieve and maintain a high level of safety and security of radioactive sources through the development, harmonization and enforcement of national policies, laws and regulations, and through the fostering of international cooperation. In particular, the Code addresses the establishment of an adequate system of regulatory control, from the production of radioactive sources to their final disposal, and a system for the restoration of such control if it has been lost.

The Supplementary Guidance on the Import and Export of Radioactive Sources provides non-binding guidance concerning the import and export of Category 1 and 2 radioactive sources, notably in relation to the evaluation of export authorization requests and pre-shipment notification.

Taken together, the provisions of these instruments, some binding, some voluntary, amount to a significant strengthening of the legal and guidance framework existing prior to 2001. The essential components of that framework were the 1987 CPPNM, to which I have already referred; INFCIRC/225, a guidance document on the physical protection of nuclear material and nuclear facilities which was first developed in the early 1970s and was last revised in 1999; and the IAEA Safeguards Agreements and their Additional Protocols, which require accounting and control of nuclear material, and the establishment of State systems of accounting and control.

Let me now start moving to a close by recalling in a bit more detail the purpose and objectives of this conference. These are, on the one hand, to look back and review our collective experience in combating illicit nuclear trafficking, and on the other hand, looking forward, to see whether we can identify ways in which existing practices can be improved, and where it might be useful for new practices to be developed. We shall be hearing from a range of distinguished experts on such issues as trafficking trends and patterns, developments in relation to international instruments and their implementation, progress in establishing detection capabilities at borders, advances in detection technologies and response methodologies, and the contribution that can be made by enhanced export and import regimes. To judge from the quality of papers and posters submitted to the Secretariat, four days of stimulating exchanges are in prospect.

Each session will have a dedicated chairperson who will be able to count on the help of a rapporteur for the preparation of summary reports. These reports will feed into the conference findings, which I shall present to you on Thursday afternoon.

Poster sessions are being held and there is a space in which a number of exhibitors have set up. Thus, participants can take advantage of breaks to view posters and exhibits.

Finally, let me remind you of the reception being offered this evening at the Scottish National Gallery, hosted jointly by the IAEA and the United Kingdom Government. All participants are warmly invited to attend.

OPENING ADDRESS

T. Taniguchi
Deputy Director General,
Department of Nuclear Safety and Security,
International Atomic Energy Agency,
Vienna

It is a great pleasure for the IAEA to have this opportunity to convene an international conference on illicit nuclear trafficking. On behalf of the Director General, I would like to express his sincere appreciation to the Government of the United Kingdom for hosting this conference.

This year, the IAEA celebrates 50 years of experience in working together with its Member States in the three areas covered by its mandate: nuclear technology, safety and verification.

While the IAEA's long standing activities in the areas of nuclear safety and safeguards also contribute to nuclear security, dedicated nuclear security programmes are generally recognized as having developed in the mid-1990s in response to concerns about an increase in incidents of illicit nuclear trafficking. The IAEA's activities in the nuclear security field took a quantum leap in 2002 when it established its first Nuclear Security Plan for 2002–2005, including protection against illicit trafficking. We are now implementing the second plan for 2006–2009, which has been approved by our Board of Governors and the General Conference in 2005. The Illicit Trafficking Database (ITDB), one of the key elements of the plan, was also enhanced significantly during this period. Ninety-nine State participants and organizations voluntarily take part in the programme. Information reported to the ITDB since the mid-1990s shows a persistent problem with illicit nuclear trafficking, thefts, losses and other unauthorized activities involving nuclear and other radioactive materials. This demonstrates a clear need for continued global efforts to prevent and combat illicit nuclear trafficking, and the necessity to develop enhanced analytical tools to better understand the trends and patterns of this phenomenon to better prevent their recurrence.

We have, over the past several years, moved forward in a number of substantive ways. Compared to six years ago, there is now universal recognition of the illicit trafficking problem and more uniform agreement on the need to take action to combat nuclear terrorism. In the past, security issues were considered strictly a national responsibility. It is now recognized that illicit trafficking not only concerns the protection of national borders but that there are vital international parameters. I would also like to note that there has been a significant improvement in equipment capability, reliability and usability. With this, resources have become available to establish national infrastructures for detection and response, and equally importantly, support has also been given to countries that do not have the resources to install an adequate detection and response system. Billions of dollars have been spent. What I would like to discuss at this conference is the basic question of whether the global community is doing enough. Can it do better?

As just noted by Peter Jenkins, President of the Conference, we now have a very strong legal platform to underpin the activities of States and the IAEA, due to recent actions by the international community. The State parties to the Convention on the Physical Protection of Nuclear Material (CPPNM) have agreed to amend and considerably strengthen the Convention by making it legally binding for State parties to establish and maintain a physical protection regime to protect nuclear material and facilities in peaceful domestic use and storage, as well as in transport. The International Convention for the Suppression of Acts of Nuclear Terrorism entered into force this year. It obligates State parties to make every effort to adopt appropriate measures to ensure the protection of radioactive material, taking into account the relevant recommendations and functions of the IAEA. Among other things, United Nations Security Council Resolution 1540 requires all States to develop and maintain appropriate effective border controls and law enforcement efforts to deter, prevent, detect and combat illicit trafficking and brokering in nuclear material. Further, more than 80 States have declared their intention to implement the non-binding Code of Conduct on the Safety and Security of Radioactive Sources. Import and export guidelines complementing this code are directly relevant to the prevention of illicit trafficking.

Further, pursuant to their respective safeguards obligations, most States are required to establish and maintain a system of accounting and control of nuclear material. These systems also contribute to preventing the loss of nuclear material. In their totality, these instruments contain obligations and political commitments for States ranging from prevention, detection and response to the mitigation of consequences of actions of nuclear terrorism. It is the most fundamental challenge to the international community to implement these instruments in a comprehensive and effective manner. We must make nuclear security an integral part of the nuclear infrastructure and consider it every day and night for all activities in which nuclear and radioactive material and facilities are used. This is increasingly important in light of the ‘nuclear renaissance’ and wide advances in the use of radioactive material under the undiminished threat of nuclear terrorism.

For this, we need an enhanced regime based on a framework of internationally accepted guidance, peer reviews, mechanisms for providing technical advice, opportunities for education, training, research and development, and well focused assistance programmes. We must recognize that this subject is of global relevance, not limited to a few countries or a single region. This global regime should be improved and these instruments implemented in a manner complementary to and coordinated with safety and safeguards regimes so that in its totality they all effectively contribute to the secure, safe and peaceful use of nuclear technology that is required for the sustainable development of the world. There will be further discussion of these instruments and their significance throughout the conference, particularly in Session 2.

The current Nuclear Security Plan for 2006–2009, which ranges over two bi-annual programme and budget periods, is comprehensive and identifies three activity areas, as well as activities supporting nuclear security.

The first activity area is entitled "Needs assessment, analysis and coordination" and is 'horizontal' in that it supports the implementation of the entire plan, and provides nuclear security relevant information, for purposes of information exchange to help prioritize activities and in support of operational activities. The ITDB programme is a cornerstone in the work to combat illicit trafficking. Trafficking information should be perceived as the precursor to malicious acts and carefully analysed and shared among relevant organizations. A so-called symptom based or precursor focused approach addressing the root causes and all the possible implications or ramifications of events should be employed. Comprehensive analysis covering illicit trafficking and other unauthorized activities and their relationship to a bigger picture will be useful for better control.

The second activity area, namely, prevention, aims at supporting sustainable capacity building in IAEA Member States to meet the threat of nuclear terrorism and of other criminal activities involving nuclear and other radioactive substances. Core activities include an effective accounting registry and physical protection, the implementation of a nuclear security culture and measures to sustain effective systems in the long term.

Should prevention fail, it will be important to have a second line of defence, which is the third activity area in the plan, referred to as "detection and response". This is the area which is of particular concern at this conference. Within this area, activities are performed to help establish enhanced capabilities at border crossings and elsewhere in countries to detect smuggling of radioactive substances. For this, effective and user friendly detection instruments are needed, both for goods, persons and vehicles. Proper procedures must be available to deal with the detection of radioactive material and the seizure of material by law enforcement organizations. Frontline officers must be comfortable in using the instruments and trust that they can get expert support when needed. In a broader context, it is necessary to prepare for situations that may, due to terrorist or criminal activities, result in the dispersal of radioactivity. Basic plans must be available to meet the radiation dispersal device threat and to deal with emergencies at nuclear installations, other locations and transports resulting from attacks or other malicious acts.

The plan outlines what must be done to achieve the goals of "prevention, detection and response". It recognizes the need to work on parallel tracks. One track is to implement the plan and provide support for the implementation of the requirements of the legal instruments: reference materials containing a set of internationally accepted guides and recommendations are being established. For the purpose of publishing such guides and recommendations, the IAEA has initiated a Nuclear Security Series. Three categories of documents are now being considered.

The first category is the security fundamentals that provide the fundamental principles for nuclear security.

The next category of documents will contain recommendations, which establish functional requirements, 'what should be done' as a basis for regulatory systems.

The third category is 'how to do it' including best practices for implementation and these are documented in implementing guides and supporting technical guidance. The documents will be subject to a broad international acceptance process, including a 120 day review period by the Member States. As a result, there will be international consensus on important principles and requirements of implementation practices.

Although we have a long way to go before the Nuclear Security Series has been fully established, five guidance documents have already been published. Four of those cover areas of particular concern to the illicit trafficking of radioactive material.

On another track, we find the IAEA nuclear security services; advisory and evaluation missions that are convened with teams of recognized international experts to evaluate the status and provide recommendations for improvements of different features of the nuclear security systems. The International Nuclear Security Advisory Service (INSServ) mission aims at determining the overall needs for improvements in a country; the International Physical Protection Advisory Service (IPPAS) evaluates in detail the physical protection at State level or at facilities, and the International SSAC Service (ISSAS) aims at evaluating the SSAC system. It should be noted that the IAEA International Regulatory Review Service (IRRS) will, for the first time, in January 2008, include a security module in an IRRS mission to Spain. We hope that more countries will follow this more integrated model in the future.

During the past 12 months, we have carried out some 30 evaluation and advisory missions plus a number of technical visits to countries receiving support, and more are planned. We have also helped States to improve regulatory systems for the safety and security of radioactive sources.

Technical support is provided to countries where the needs assessment has reflected an urgent need. During the past 12 months, physical protection improvements have been initiated at nuclear facilities in five countries, and for approximately ten high activity unprotected radioactive sources in non-nuclear use. We have delivered a total of 1500 pieces of detection equipment to 43 States, all tested by our nuclear security equipment laboratory. The need for item testing of the equipment is evidenced by the high rejection rate for some instruments: up to as many as 30% of the instruments tested this year.

Nuclear and radiological security must clearly be considered at major public events. We carried out joint projects with the Government of Greece for the 2004 Olympics, with the German authorities in connection with the Football World Cup in 2006, with Qatar regarding the 2006 Asian Games, and with Brazil for the Pan-American Games in 2007. We are currently consulting with China about the 2008 Olympics and the World Exposition in 2010.

On another track, capacity building is given high priority in the implementation of the plan. Human resource development, with education and training, is one of the most important implementation tools. The Nuclear Security Plan includes making available to all States a programme of education and training in different subjects and for different target audiences at the international, regional and national levels. Since 2003, about 200 training events have been carried out with more than 4000 participants from more than 120 countries. We have established graduate level training and national security support centres in the Russian Federation, Greece, China, India and Ukraine. A special programme for human resource development has been developed with Pakistan, the Middle East and North Africa. The goal is to have a network of regional centres or training hubs to offer education and training periodically and predictably.

The IAEA has also strengthened its efforts of international coordination. Regular meetings are convened with Member States and other international organizations in this regard. The IAEA develops, in consultation with individual States, integrated nuclear security support plans which bring together all the work that is required to implement, among other things, the obligations of the legal instruments that are relevant in the nuclear area. These plans provide a comprehensive work plan for an individual country and can be used to help in the coordination of activities and generating the required resources. The plans improve the efficiency of existing resources and help to avoid gaps. All activities are performed with due consideration to maintaining confidentiality of sensitive information.

The cost of activities carried out by the IAEA in the nuclear security area during 2006 was approximately $20 million. The IAEA's programmes and activities in this area are funded mostly from extrabudgetary funds through the Nuclear Security Fund. In addition, significant in kind contributions are received from Member States.

The IAEA believes that the continued high level of extrabudgetary and in kind support for its Nuclear Security Plan underscores the value that States place in the IAEA's work. Member States regard the plan as a well coordinated programme that was devised in consultation with States. The regular coordination with donors and recipients ensures that the plan remains responsive to States' needs and to the changing international situation. However, in the medium and long term, an increasing regular budget share to improve stability, predictability and overall balance of nuclear security activities is necessary for core IAEA functions and common horizontal activities.

Apart from elaborating on where we, the international community, have been both effective and ineffective, this conference is also to set the way forward. I hope to hear many good ideas about this: not only with respect to IAEA programmes but how the donors and recipients view the situation, and what they hope to achieve, how they might achieve these goals and which national and international cooperation they may need.

Let me then be the first to begin. The IAEA believes that there should be a deepening and widening of the analysis of information and the sharing of results of these analyses as common lessons. The IAEA is ready to continue to help the capacity building process for prevention and detection through the establishment of regional nuclear support centres to more effectively and efficiently provide the needed cooperation. We are also ready to establish comprehensive and consistent guidance for an internationally harmonized approach and better capabilities to meet national responsibilities for response, recovery and restoration obligations, including nuclear forensics. We believe that it is extremely important to develop an expert nuclear security community in much the same way that nuclear safety and non-proliferation have. There is a need to encourage the development of and the use of global specifications of software and hardware for border detection, and the IAEA is prepared to take a leading role in that effort. Of course, we all need to promote research and development to establish more effective approaches and techniques for combating illicit trafficking. Finally, it is important that we all work together, cooperating in a mutually enhancing and well coordinated manner. We should also avoid duplication of programmes and services in order to ensure that our important activities are not mutually weakening between different initiatives and activities.

The IAEA welcomes the continuing support it has received from the international community, particularly the necessary high level political support for our activities in the area of helping States combat terrorism. We are in the same global boat in the fight against nuclear terrorism and our activities should continue to contribute to that goal.

I wish you well during this week and look forward to a comprehensive set of conclusions that we can consider on our way forward.

More than six years after 11 September 2001 and more than ten years after the ITDB was initiated by the IAEA, it is timely to review and share our collective experience, and explore the way forward by our collective insight and foresight. The IAEA is planning to host an international conference on comprehensive nuclear security in December 2008 in the brand new IAEA Conference Centre to prepare for the next four year cycle of the Nuclear Security Plan for 2010–2013. I am convinced that this conference, focusing on the major symptoms and precursors of severe nuclear security events, will provide very valuable input to future planning in a broad context.

Thank you.

OPENING ADDRESS

W. Nye
Office for Security and Counter-Terrorism,
Home Office,
London, United Kingdom

1. INTRODUCTION

On behalf of Her Majesty's Government, I would like to welcome you all to Edinburgh for this IAEA Conference on Illicit Nuclear Trafficking. I am delighted that the United Kingdom Government has been able to support this conference through our Global Threat Reduction Programme, and I am sure that it will provide a valuable opportunity for us to exchange views and ideas on this important subject.

This morning, I intend to briefly cover two main areas; first, a snapshot of the continuing threat and the recent changes we have made to the United Kingdom's counterterrorism structures to respond to it; and second, how the United Kingdom is combating nuclear terrorism through a range of measures covering physical security, decreasing vulnerability to attack and increasing resilience.

2. THE CONTINUING THREAT AND RECENT CHANGES TO THE UNITED KINGDOM'S COUNTERTERRORISM STRUCTURES

Since 2001, there have been several attempts to obtain radiological material for use in a 'dirty bomb'. For example, in the United Kingdom, Operation Rhyme — the investigation into a cell planning attacks on buildings in the United Kingdom and the USA — resulted in the conviction of eight terrorists who, in addition to their plans to blow up limousines packed with gas cylinders and explosives, were considering using a radioactive bomb. This reflects a growing trend towards chemical, biological, radiological and nuclear (CBRN) terrorism as terrorists increasingly look for the next 'spectacular' attack.

Similarly, we have seen Al Qaeda's leader in Iraq calling for nuclear scientists to join the global jihad and there is no doubt that core Al Qaeda retains the ambition to build or obtain nuclear weapons. At the moment, it is questionable whether this intent is backed up by a real capability. However, the numerous successful interceptions of radiological and fissile material by security forces worldwide show that it is possible to obtain materials of concern which, when coupled with this intent, paints a worrying picture of continuing and increasing threats from radiation dispersal devices (RDDs) and INDs.

As a director within the relatively new Office for Security and Counter-Terrorism (OSCT), I am keenly aware that combating this threat from nuclear terrorism requires an international effort. In a world affected by global terrorism, where the Internet enables the easy exchange of knowledge and ideas, and where the movement of people is greater than at any time in human history, no country can deal with the threat on its own. Radiological and fissile materials are present throughout the world and, as such, we must look to secure them wherever they are found.

I would like to take this opportunity to encourage all countries to continue to enhance security and protection mechanisms for radiological and fissile material; and to develop contingency plans should the worst happen. In the United Kingdom, we have responded to the very serious and real threat by consolidating and strengthening elements of our counterterrorist planning via the creation in May this year of the OSCT. These changes have been coupled with an unprecedented level of investment to enable the delivery of the United Kingdom counterterrorist strategy — known as CONTEST — through which we aim to:

— Stop terrorist attacks;
— Where we cannot stop an attack, to mitigate its impact;
— Strengthen our overall protection against terrorist attack;
— Stop people becoming terrorists or supporting violent extremism.

In the case of radiological and nuclear terrorism, it is not sufficient merely to prepare for such an attack; we must also devote efforts to preventing such attacks in the first instance by intercepting dangerous materials before they reach their intended target; and by strengthening our protection of vulnerable places and detecting or mitigating any devices before they are placed or activated.

As such, in terms of the United Kingdom's efforts on radiological and nuclear terrorism, we see three main strands to this work: physical protection of materials; decreasing vulnerability to attack; and increasing resilience should an incident occur.

3. PHYSICAL PROTECTION

There is no doubt that the best way to prevent nuclear terrorism is to stop unauthorized access to fissile material. In the United Kingdom, the Office for Civil Nuclear Security (OCNS) independently regulates the security of our nuclear facilities and we ensure that we comply with the highest internationally recognized standards.

Nevertheless, the United Kingdom recognizes the need to continue to progress in this area which is why we strongly support the work of the United Nations 1540 Committee and will work to roll over its mandate when it expires next year. We are on course to ratify the International Convention for the Suppression of Acts of Nuclear Terrorism in December this year, and to complete the ratification of the amended Convention on the Physical Protection of Nuclear Material in early 2008. We would encourage other States to do the same and to join us in placing the highest priority on securing all materials of concern.

4. GLOBAL THREAT REDUCTION PROGRAMME

In addition to our own portfolio of domestic work on nuclear security, the United Kingdom is operating and extending a programme of collaboration and international assistance aimed at reducing the threat of proliferation of nuclear and radiological materials.

These programmes fall under the umbrella of the United Kingdom's Global Threat Reduction Programme (note there is a poster display and presentation of our work outside), which has an annual budget of around £35 million, focusing on a wider range of CBRN non-proliferation and threat reduction activities. For example, a few of the current projects include:

- Assisting the Russian Federation to make safe and secure some 21 000 spent nuclear fuel assemblies from decommissioned nuclear submarines and other nuclear vessels;
- Construction of a storage facility for spent nuclear fuel at Atomflot, Murmansk, Russian Federation;
- Assistance to improve security at civilian nuclear sites across the former Soviet Union;
- Contributing to the international effort to achieve the safe and irreversible shutdown of the BN350 Fast Breeder Reactor at Aktau, Kazakhstan.

The United Kingdom is now also supporting physical protection upgrades at seven sites in the Russian Federation. These are all civilian sites and the programme focuses principally on protection of Category 1 nuclear materials with much of the work orientated towards creating inner security boundaries around key facilities. The aim is to bring security up to recognized international standards wherever possible. At the majority of sites, contracts are now in place and it is anticipated that the majority of major site work will be completed by late 2009 at a cost of approximately £15 million.

Part of this programme also includes a training and interchange programme, or more correctly, a nuclear security workshop, which is initially targeted at key security officials working at sites where the United Kingdom is funding security upgrades. We are currently in the process of widening these workshops to address a wider delegate selection from key partner nations.

We are also active outside the Russian Federation in countries such as the Ukraine, Tajikistan, Kazakhstan, Armenia and Belarus. Much of the work outside the Russian Federation is delivered through our contribution to the IAEA Nuclear Security Fund where the United Kingdom is now the third largest State donor. We greatly value this collaboration as it is clear that the IAEA plays a critical role in enabling international collaboration in this sensitive area and offers us unique possibilities to support this kind of work.

Over the next 12 to 18 months, we will be driving these programmes forward; but to do so we rely very heavily, not only on the expertise of organizations such as the IAEA, but also on the willingness of our partners and recipient nations to collaborate with us in this sensitive and critical area. To date, our experience is that such collaboration, while perhaps difficult to initiate, is now delivering very valuable results, not just in the establishment of physical infrastructure but, just as importantly, in the establishment of shared goals and aspirations between countries for future safety and security.

5. DECREASING VULNERABILITY

While securing radiological and nuclear material is the best way to prevent an attack, we must face the fact that worldwide security regimes are unlikely ever to be foolproof. As such, we must be vigilant against the movement of radiological and fissile material across borders, as well as putting in place measures to deal with suspect devices if they are discovered.

Since 2003, Programme Cyclamen has been introducing radiation screening equipment at United Kingdom airports and seaports. Interim operating capability is now up and running, along with mobile facilities which can be used for screening at smaller ports or during important public events. As we have developed this capability, we have had to deal with a number of issues — not least how to balance the need to achieve high throughput of cargo to keep the ports running efficiently against the necessity to perform thorough checks and inspections. We continue to build on this initial capability and you will hear later in the conference from the Cyclamen team on our response to risk at the United Kingdom border.

Nevertheless, it is not sufficient to merely intercept dangerous nuclear cargo. We need to have plans in place covering what to do should we find suspect material or a suspect device at the border or elsewhere. Because of this, the United Kingdom has, for many years, been developing and maintaining a disablement and render safe capability for RDDs and INDs. This capability currently integrates operational, technical and scientific expertise into a single organization to provide a ‘one stop shop’ for dealing with radiological and nuclear devices.

These arrangements have been very effective at building skills and expertise, but we are now starting to examine whether they have the flexibility required to respond to the increasing and changing threat. As such, we are now looking at deploying more capability into the field and supporting it with remote scientific expertise through communications architecture and reachback facilities in order to reduce response times and provide United Kingdom-wide coverage.

6. INCREASING RESILIENCE

Should all these efforts fail and an attack take place, either in the United Kingdom or abroad, we must be prepared to deal with the consequences. In the United Kingdom, the Home Office led CBRN resilience programme has, since 2002, been committed to putting in place measures to deal quickly and effectively with the consequences of a CBRN attack. This has included £60 million of new personal protective equipment for the police and £56 million for at scene decontamination through the new dimension programme. We have already provided personal radiation dosimeters to all paramedics and are in the process of providing dosimeters for all CBRN trained police.

As well as bringing new equipment on stream, we have also emphasized the need for multi-agency training and exercising as a means to test and develop our contingency planning. The United Kingdom has, for several years, had regular CBR exercises, including a number dealing with RDD scenarios, which have helped us develop our understanding of both crisis and consequence management. In the absence of any data from ‘real’ incidents, these exercises provide a unique way of teasing out issues and learning lessons.

Through them, we have recognized that an effective response is only possible if all the agencies involved understand each other's roles and responsibilities and are pulling together to deliver a shared vision. It is not enough simply to be good at what you do. You have to appreciate what everyone else does as well.

Many of these exercises include observer programmes where representatives from overseas governments and agencies are able to see what the United Kingdom does and why. In our experience, these observer programmes can provide a valuable way of sharing best practice between nations and we would encourage other countries interested in developing their contingency planning arrangements to see if they can learn from us. In turn, we have found that the insights offered by other countries into our way of doing things can often make a valuable contribution to our own improvement processes.

7. FUTURE GOALS

In short, we have come a long way in the last five years but much remains to be done. We must continue to work hard to improve nuclear security around the world in order to prevent access to radiological and nuclear materials. We also need to develop better interception and trafficking solutions to ensure dangerous materials cannot be unlawfully moved across borders, and improve our ability to undertake nuclear forensics and attribution as a means of tracking the source of any trafficked material. Finally, our contingency planning arrangements must evolve to keep pace with the threat. The terrorists' intent is to mount radiological and nuclear attacks. We must ensure that we do everything possible to stop them succeeding.

OPENING ADDRESS

Ambassador P. Burian, Chairman
1540 Committee, United Nations Security Council Committee,
United Nations,
New York

1. INTRODUCTION

In the Preamble of its Resolution 1540 (2004), the United Nations Security Council clearly expresses its view that illicit trafficking of nuclear, chemical and biological weapons, their means of delivery and related materials "adds a new dimension to the issue of proliferation of such weapons and also poses a threat to international peace and security." Adopted under Chapter VII of the United Nations Charter, Resolution 1540 (2004) — hereafter UNSCR 1540 — sets out several obligations and recommendations for United Nations Member States, including specific requirements regarding illicit trafficking in operational paragraph (OP) 3(c), where it decides that all States shall take and enforce measures to prevent WMD proliferation including:

> "(c) Develop and maintain appropriate effective border controls and law enforcement efforts to detect, deter, prevent and combat, including through international cooperation when necessary, the illicit trafficking and brokering in such items in accordance with their national legal authorities and legislation and consistent with international law."

UNSCR 1540 also created a committee to monitor and report on the measures taken by States to implement these obligations, known as the 1540 Committee.[1]

The most mature of the international non-proliferation regimes, governments and their border control agencies have had several decades to develop means to detect, deter, prevent and combat illicit trafficking in nuclear weapons, their means of delivery and related materials. The Security Council, however, adopted UNSCR 1540, in part, to close gaps in the traditional

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[1] Initially created for a two year term, the Committee was established pursuant to United Nations Security Council Resolution 1540 (2004), also known as the 1540 Committee, and had its term extended by United Nations Security Council Resolution 1673 (2006) through April 2008.

international regimes by the threat posed by illicit trafficking involving non-State actors.[2] In this paper, I will discuss the extent of the gaps in these national and international nuclear non-proliferation systems identified by the 1540 Committee.

2. THE EXTENT OF THE PROBLEM

With the revelations of the A.Q. Khan and other non-State networks that fostered proliferation, UNSCR 1540 addressed, among other problems, the growing concern that most international non-proliferation treaties focused only on the behaviour of States, and excluded non-State actors. The Nuclear Non-Proliferation Treaty (NPT), for example, obliges its State parties, both nuclear weapon and non-nuclear weapon States, to prevent proliferation to other States. While the IAEA maintains close ties with State and non-State actors orientated towards nuclear commerce and research, States constitute its membership and governing bodies, and it can only conduct inspections and otherwise verify treaty compliance in cooperation with States. By creating obligations for States regarding non-State actors, UNSCR 1540 supplements the existing NPT and other nuclear non-proliferation treaty regimes.

At the same time, in OP 5 of UNSCR 1540, the Security Council also makes very clear that the resolution does not replace, alter or impinge upon existing rights and obligations under those regimes. Moreover, in OP 8 of UNSCR 1540, the Security Council calls upon all States, not just United Nations Member States, to promote the universality of these treaties. To explore the breadth of the gaps between the existing NPT regime and the potential for non-State actors to acquire nuclear weapons or their means of delivery, one might begin by looking at which States have significant nuclear assets and what measures, for example, as set out in OP 3(c) mentioned previously, they have taken that apply to non-State actors.

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[2] UNSCR 1540 defines non-State actors as an "individual or entity, not acting under the lawful authority of any State in conducting activities which come within the scope of this resolution."

At least 81 States on six continents have some form of nuclear infrastructure, with at least one nuclear fuel cycle facility, power reactor, research reactor or uranium deposit.[3] That several more States have no significant nuclear assets but have a first rank trade facilitation infrastructure that traffickers might use (e.g. Malta, Panama, Singapore and the United Arab Emirates), and all of these nearly 90 States have neighbours whose borders illicit traffickers may wish to exploit, clearly makes this a truly global concern. For our purposes, however, let me look at the measures taken by that core of 81 States.

For the April 2006 report of the 1540 Committee to the Security Council, nine of these 81 States did not submit a national report to the Committee. While this raises several significant concerns, including limiting the capacity of the 1540 Committee to facilitate relevant assistance to these States, I will exclude these States from this discussion, to examine the activities of the remaining 72 States. Meanwhile, I call on these States to submit national reports as soon as possible.

For each State, the 1540 Committee seeks information on the legislative and enforcement measures taken to meet the many obligations that stem from UNSCR 1540. For each, it relies on a matrix prepared by the 1540 expert group that helps the Committee classify information according to approximately 380 questions relevant to the specific requirements of UNSCR 1540, using data from the State's national report, additional information that the State may have submitted to the Committee and to international governmental organizations (IGOs), and other official public information made available by the State. In this presentation, let us look more narrowly at eight questions of particular relevance to illicit trafficking in nuclear materials, which UNSCR 1540 broadly defines to include dual-use as well as special purpose items. The questions are whether a State has legislation specifically related to nuclear materials for

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[3] Using data from the IAEA, these States include Algeria, Argentina, Armenia, Australia, Austria, Bangladesh, Belarus, Belgium, Brazil, Bulgaria, Canada, the Central African Republic, Chile, China, Colombia, Democratic Republic of the Congo, Czech Republic, Denmark, Egypt, Estonia, Finland, France, Gabon, Georgia, Germany, Ghana, Greece, Hungary, India, Indonesia, Islamic Republic of Iran, Iraq, Israel, Italy, Jamaica, Japan, Jordan, Kazakhstan, Democratic People's Republic of Korea, Republic of Korea, Kyrgyzstan, Latvia, Libyan Arab Jamahiriya, Lithuania, Madagascar, Malaysia, Mexico, Mongolia, Morocco, Namibia, the Netherlands, Niger, Nigeria, Norway, Pakistan, Peru, the Philippines, Poland, Portugal, Romania, Russian Federation, Slovakia, Slovenia, Somalia, South Africa, Spain, Sweden, Switzerland, Syrian Arab Republic, Tajikistan, Thailand, Tunisia, Turkey, Turkmenistan, Ukraine, United Kingdom, United States of America, Uruguay, Uzbekistan, Venezuela and Vietnam.

border control, trading or brokering of nuclear items, export controls, control lists that include nuclear items, and controls on the transit, trans-shipment, re-export or import of nuclear items.

As Table 1 indicates, the largest gaps exist in establishing legal frameworks for trans-shipments, trading or brokering of items and re-exports. While the majority of the 72 States with some nuclear infrastructure have created legislative frameworks in the other categories, there is no category in which more than 56 (78%) of the 72 States have done so.

Digging deeper, what about the distribution of these actions? Are a small number of States taking most of the measures? To explore this question, if the Committee found evidence that a State has developed legislation or regulations in one category, say border controls, it counted the State as having taken one measure. If the Committee found evidence that a State has produced legislation or regulations in two categories, say border controls and export controls, then it counted the State as having taken two measures and so forth.

The results of counting the measures taken appear in Fig. 1. On average, the 72 States created legislative measures in nearly five categories of a possible eight related to illicit nuclear trafficking.[4] Only eight States appear to have no legal framework on these aspects of nuclear trade, while twice that number have some form of legal framework that applies to each category. While this distribution bodes well for tackling the issue of the acquisition of nuclear weapons, their means of delivery, and related materials by non-State actors, it does suggest that the international community must do considerably more.

TABLE 1. STATES WITH LEGISLATIVE MEASURES RELATED TO THE PREVENTION OF ILLICIT NUCLEAR TRAFFICKING

Category	No. of States
Border controls	55
Trading or brokering controls	32
Export controls	56
Control list(s)	46
Transit controls	42
Trans-shipment controls	26
Re-export controls	34
Import controls	52

[4] The average is 4.76.

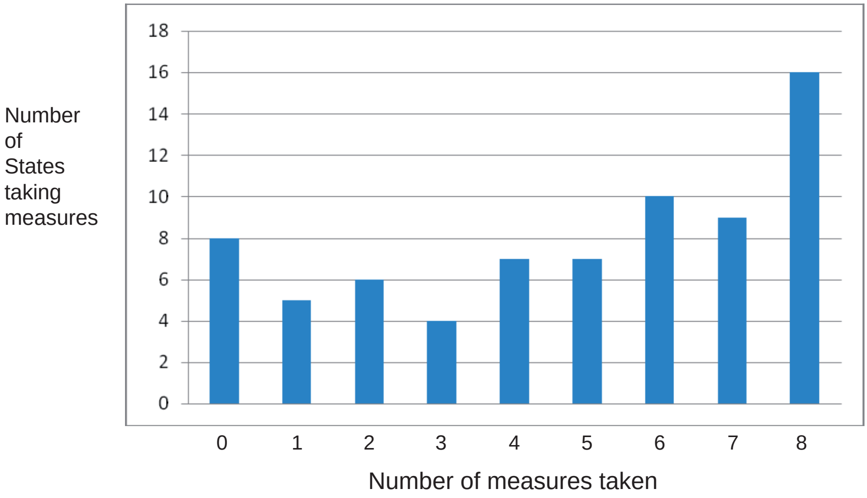

FIG. 1. Number of States by number of measures taken to prevent illicit nuclear trafficking.

3. WHAT NEXT?

The 1540 Committee recognizes the need to help the international community close these gaps. The Committee has no mandate for nor interest in replicating the work done by the IAEA, including development of its Illicit Trafficking Database on nuclear material, and other IGOs, such as the World Customs Organization which has a cooperation arrangement with the IAEA, regarding nuclear non-proliferation. Instead, the 1540 Committee would like to work in even closer cooperation with the IAEA and other IGOs to develop mechanisms to share appropriate information and foster the global effort to combat nuclear proliferation.

Further, the 1540 Committee participated in regional and subregional outreach programmes across the globe to promote implementation of UNSCR 1540, including the obligations related to nuclear non-proliferation. It has worked with States requesting assistance to help make their requests more effective. It has brought together States and IGOs that offer assistance in an effort to enhance the efficiency and effectiveness of assistance programmes, and to bring attention to those States that have asked for help.

On a larger scale, the 1540 Committee continues to play a unique role in the effort to stem the proliferation of WMD to non-State actors. Its mandate encompasses biological, chemical as well as nuclear proliferation, giving it insights into problems that cut across all types of WMD proliferation. Notably, the gaps identified in this presentation on illicit nuclear trafficking parallel gaps the Committee has identified for illicit trafficking of biological and chemical items as well. This suggests that it might prove especially helpful for States to coordinate their efforts against illicit trafficking in WMD generally, for example, in building State capacity to improve both risk assessment and border security, which will have benefits for illicit trafficking in nuclear items in particular.

Thank you.

OPENING ADDRESS

S. Aoki
Deputy Under Secretary for Counterterrorism,
US Department of Energy,
Washington, United States of America

It is a great honour to be invited to participate in the opening session of this very important international conference, marking the IAEA's continued involvement in global efforts to prevent illicit trafficking in nuclear and radioactive materials. I understand our topic today is a review of where we, as an international community, have come and where we need to go in this effort.

Unfortunately, this continues to be a timely subject. The IAEA's database records over 600 events between 1993 and today. While the vast majority of these have turned out to be scams and frauds rather than real instances of nuclear smuggling, there have certainly been at least a few cases in which traffickers managed to obtain actual weapons grade nuclear material. Many of us here will remember the Prague and Munich events some 13 years ago, and more recently there have been some well publicized cases in Georgia. In a world overshadowed by the threat of international terrorism, this is not a risk we can ignore.

Recognizing that the danger is truly global, governments have in recent years taken a number of steps to outlaw unauthorized trafficking in nuclear or radioactive materials and build a framework for international cooperation to prevent it. The Convention on the Physical Protection of Nuclear Material (CPPNM) has, from its inception, required parties to ensure that nuclear material exports receive adequate protection during transport, and calls for international cooperation and assistance in the event of theft of nuclear material. The 2005 Amendment to the CPPNM reinforces and extends the scope of these commitments. The International Convention for the Suppression of Acts of Nuclear Terrorism, also adopted in 2005, makes clear that the use of radioactive material or the sabotage of a nuclear facility to cause death or injury must be regarded as a crime, and obligates its parties to cooperate and share information to prosecute anyone who may be responsible. The Security Council has also acted on United Nations Security Council Resolution 1540 to mandate that all States refrain from supporting the acquisition of nuclear weapons by non-State actors and put in place effective physical protection, border security and export control measures to prevent such assistance.

Taken together, these and other measures adopted by the international community create an unambiguous commitment to make illicit nuclear trafficking illegal and to cooperate in its suppression. Perhaps more important than formal legal measures alone are the actions governments have initiated to institute practical cooperation in this field. Of course, the IAEA has been a leader in this effort, as reflected in the Nuclear Security Plan. Of the many areas where the IAEA has contributed, let me cite three: the development of the Code of Conduct on the Safety and Security of Radioactive Sources, the numerous efforts through technical assistance programmes to assess physical protection needs and to build national capacity to implement physical protection systems, and the collection and dissemination of information through the Illicit Trafficking Database.

Other important cooperative steps have been taken by States acting together to develop training and communications channels to facilitate intervention in an ongoing illicit transfer or to build national capacity to protect nuclear materials and respond to security threats. Participants in the multilateral proliferation security initiative have put in place and field exercised cooperative procedures to interdict sea and air shipments of materials related to weapons of mass destruction, potentially including nuclear material and related technology. Recently, some 60 nations have joined the Russian Federation and the USA — the co-sponsors — as partners in the Global Initiative to Combat Nuclear Terrorism. Under this initiative, participating countries share best practices and participate in exercises designed to build national and multilateral capacity to prevent nuclear terrorism, including illicit trafficking in nuclear materials. Participants in global initiative workshops and exercises have included law enforcement and security officials with day to day responsibility for implementing measures against illicit trafficking. These visible forms of international cooperation are backed up by numerous bilateral assistance and cooperation programmes directed at improving physical protection, including during transport, consolidating and eliminating unused nuclear materials and radioactive sources, bolstering nuclear detection at ports and borders, strengthening the ability of law enforcement agencies to identify and prosecute nuclear smuggling cases, developing procedures and protocols to intervene in emergency situations involving nuclear or radioactive materials, and exchanging information on nuclear terrorism threats.

Turning to the second major theme of this conference, what should be the way ahead for international cooperation against illicit nuclear trafficking? Part of the answer really is more of what we are already doing successfully. We need to continue and to strengthen the multilateral cooperation I have just outlined, with an increased emphasis on building practical measures of information sharing and timely mutual assistance at the operational level. This should involve active participation by both nuclear specialists and those with more general security and law enforcement roles. Exercises and other ways to establish international contacts in advance of an actual event will be important to developing the effective implementation of the commitments incorporated in major international agreements.

A related point is the need to give priority to developing national capacity to evaluate security threats, ensure adequate physical protection and intervene in ongoing nuclear trafficking cases. All of our ability to cooperate internationally rests on the foundation of national capabilities; programmes to develop these capabilities through exchanges of best practices, training and other assistance should continue to be supported, both bilaterally and through international institutions.

Actions to reduce the risk that nuclear materials will be stolen or diverted, and to increase the likelihood that those engaged in nuclear smuggling will be apprehended can be complemented by cooperation in the areas of forensic analysis of nuclear materials and of emergency response should nuclear or radioactive materials be found in an unauthorized place. These are both areas where we can significantly strengthen the level of information sharing, technical exchanges and cooperative planning. Among other things, demonstrating that we have the ability to frustrate an attempt to put nuclear or radioactive materials to malevolent use and can identify the source of the materials involved will improve our ability to deter would-be smugglers, terrorists and those who might be tempted to assist them.

Let me conclude by outlining a few things the USA is doing to support the global effort to prevent illicit nuclear trafficking and to help define the road ahead. Most of these activities will be described in greater detail by other speakers at this conference.

The USA continues to believe that the most effective way to prevent illicit trafficking is to ensure that all nuclear materials are well secured and accurately accounted for by their authorized holders. Cooperative programmes that began nearly 15 years ago have strengthened security at nuclear sites in the former Soviet Union and have permitted the removal and elimination of unneeded nuclear and radioactive materials from a number of countries. Together with our Russian Federation partners, we recently announced the completion of security upgrades at strategic weapons sites and agreement on measures to ensure the long term sustainability of physical protection improvements in the Russian Federation. We are also working to convert research reactors and return high enriched uranium fuel from locations around the world that might otherwise become a target for terrorists or thieves.

In parallel with efforts to improve security at the source, we are building international cooperation to put in place nuclear detection at seaports, airports and land border crossings. Through collaboration with the Russian Federal Customs Service, all of the Russian Federation's official border crossings will be equipped with radiation detection equipment by 2011. As part of an integrated nuclear detection architecture, we are also partnering with port operators around the world to put similar detectors in place to scan seaborne cargo. These detection systems are designed to be effective against undeclared shipments of nuclear materials but also provide the ability to identify other radioactive sources or materials.

In support of the Global Initiative to Combat Nuclear Terrorism, we sponsored a law enforcement conference in the USA earlier this year and attended similar meetings in other countries. These events enable us all to improve our understanding of national and international responses to illicit trafficking and for technical experts to exchange observations on best practices. We are looking forward to participating in an international workshop in China, where we will be demonstrating search techniques to locate and identify radioactive sources. We expect that international cooperation in this area of emergency response procedures will increase. We have already offered to make available to several partners direct access to our national capabilities to assess remotely collected radiation spectra and to model the atmospheric dispersion of hazardous materials, including radioactive debris. We are willing to entertain requests from additional countries for access to these diagnostic and assessment tools.

In conclusion, let me once again express my appreciation to the organizers of the conference for assembling a comprehensive and challenging programme. We have clearly accomplished a great deal — and equally clearly have opened the door to many new and productive areas for cooperation.

OPENING ADDRESS

K. Suganuma, Consul General
Consulate General of Japan in Edinburgh,
Edinburgh, United Kingdom

1. INTRODUCTION

Mr. President, Deputy Director General Taniguchi, distinguished delegates, ladies and gentlemen,

Nuclear energy has provided an invaluable contribution to humankind in various areas including power generation, human health, agriculture and industry. However, nuclear material and technology must be handled with great care, and if used maliciously, can be extremely harmful. Nuclear terrorism, should it happen, could cause immeasurable damage and psychological impact on our whole society.

Strengthened nuclear security measures are therefore critical to harness the potential of this important resource, and to secure the development of its peaceful use. Since the terrorist attacks on 11 September five years ago, in particular, keeping nuclear and radioactive materials out of the hands of terrorists and other non-State actors has become a new challenge for the international community. This is an area where coordinated international efforts are essential and where we can now see development on many fronts.

The IAEA has always been at the centre of these efforts. It established a Nuclear Security Fund in March 2002 within six months of 11 September, which provides for a framework to help States to build up national capabilities to guard against malicious acts of nuclear terrorism. Organizing this conference is one of the latest contributions by the IAEA amid a series of efforts by the international community.

Our response in this field needs to take into account the changing international environment. One of the areas that requires a new focus is today's so-called 'nuclear renaissance'; a growing number of countries — according to some calculations, around 30 countries — have expressed their interest in embarking upon nuclear programmes. This trend is likely to continue because of growing concern over energy security and global warming. It is therefore urgent to lay a foundation of nuclear security in those countries before they actually embark upon a nuclear programme.

In this regard, this meeting — aimed at discussing our way forward — is most opportune and timely. I would, therefore, like to pay my tribute and express my appreciation to the IAEA for organizing this meeting and to the Government of the United Kingdom for hosting it.

Now, on behalf of the Government of Japan, I would like to share with you, some of Japan's experience of international cooperation in this field, and to provide you with an Asian perspective.

2. ENHANCING NUCLEAR SECURITY IN ASIA

Asia is the region that Japan belongs to, and where a growing number of countries are considering the introduction of nuclear power plants. Therefore, we consider that it is a priority region in our efforts to strengthen nuclear security. Japan has actively taken measures to extend assistance to Asian neighbours, through bilateral cooperation and multilateral arrangements, such as IAEA projects and the Global Initiative to Combat Nuclear Terrorism.

Being fully aware of the IAEA's central and important roles in the field of nuclear security, Japan has cooperated closely with the IAEA in this regard. One of our efforts was holding a seminar on strengthening nuclear security in Asian countries in November 2006, making use of Japan's contribution to the IAEA Nuclear Security Fund. The seminar was organized for the first time in Asia to address nuclear security matters, in which more than 100 experts from 19 countries participated. Japan also hosted a seminar, in March this year, aimed at promoting the accession to the international counterterrorism conventions and protocols, inviting government officials and experts from Asia Pacific countries. At the seminar, Japan presented its experience and lessons learned with regard to its ratification of relevant international conventions such as the International Convention for the Suppression of Acts of Nuclear Terrorism and the Convention on the Physical Protection of Nuclear Material. As a result of these efforts, there is wider understanding about the importance of those conventions among officials and experts, and they seem to be more motivated to establish their national, legal basis necessary for strengthening nuclear security, and to seek early accession to those conventions. Japan will continue to undertake such endeavours.

Japan has also provided assistance for capacity building in the field of physical protection measures, and is preparing three projects for Asian countries through the IAEA Nuclear Security Fund. In Thailand, Japan has a project aimed at improving physical protection of nuclear research facilities. In Vietnam, Japan plans to host a workshop on radiation detection equipment for border officials and is also preparing for a seminar aimed at capacity building of control on nuclear material in Vietnam.

I would also like to mention that Japan is committed to continue its efforts to make the IAEA Comprehensive Safeguards Agreement together with an Additional Protocol the universally accepted verification standard for the peaceful use undertakings of the Nuclear Non-Proliferation Treaty.

Here I would like to remind you of Japan's basic policy on bilateral nuclear cooperation agreements. Considering the dual nature of nuclear material and technology, Japan is of the view that three Ss, that is, S for 'safeguards' (non-proliferation), S for 'safety' and S for 'security', are indispensable infrastructure for the introduction of nuclear power plants. Japan, therefore, regards these three Ss as a prerequisite when it starts bilateral talks for nuclear cooperation agreements with other countries. For the same reason, Japan has extended assistance to countries concerned to develop the necessary infrastructure to assure the three S's. Acknowledging the importance of the Additional Protocol in ensuring nuclear non-proliferation, Japan requests, as a matter of policy, that the Additional Protocol be concluded before Japan starts bilateral talks for nuclear cooperation agreements. Furthermore, in the framework of NSG, Japan proposes that conclusion of the Additional Protocol be a prerequisite for the export of nuclear related items.

3. ASSISTANCE TO COUNTRIES OF THE FORMER SOVIET UNION

Second, let us turn our eyes westward. As the issue has global implications, Japan considers that the countries of the former Soviet Union deserve high priority attention, and has rendered assistance to these countries as well. Japan has also concluded bilateral agreements and carries out projects on denuclearization with Kazakhstan, Ukraine and Belarus. Japan has also extended assistance to these countries through the IAEA Nuclear Security Fund.

3.1. Assistance to Kazakhstan

In Kazakhstan, Japan supplied flow monitor equipment, a nuclear material protection system and an accountancy and control system for the Aktau fast breeder reactor (BN-350), as well as a nuclear material protection system to the Kazakhstan Atomic Energy Agency (then) and the Atomic Energy Research Institute, and an accountancy and control system for the Atomic Energy Agency (then). In addition, the project on upgrading of the nuclear material control and accounting system for the Ulba fuel fabrication facility, a former nuclear weapons production plant, was concluded last year.

The regional training course on physical protection was held in Kazakhstan in July 2007 with Japanese cooperation.

Japan and Kazakhstan signed a memorandum on the promotion of cooperation in the field of the peaceful use of nuclear energy on the occasion of the visit of Prime Minister Koizumi in August 2006. In order to follow up this memorandum, a delegation was sent to Kazakhstan, visiting the Ulba metallurgical plant, the Institute of Nuclear Physics and other facilities concerned. Based on the study of this mission, the Government of Japan decided to cooperate on the improvement of nuclear security at those two facilities.

Taking into account the fact that Kazakhstan ratified the IAEA Additional Protocol in April 2007, Japan is now negotiating a bilateral nuclear cooperation agreement with Kazakhstan.

3.2. Assistance to Ukraine

As to Ukraine, Japan provides assistance for the improvement of a system for nuclear material accountancy and control, and physical protection of nuclear and other materials. Japan supplied equipment for this purpose to the Kharkov Institute of Physics and Technology (KIPT), the State Nuclear Regulatory Committee of Ukraine (SNRCU) and the Kiev Institute for Nuclear Research.

3.3. Assistance to Georgia

A project on improving the capability to detect trafficking in nuclear and radioactive materials is being implemented with Georgia by using Japan's contribution to the IAEA Nuclear Security Fund.

3.4. Assistance to Belarus

In Belarus, Japan provided the academic scientific–technical centre "Sosny" and the Department for Supervision of Industrial and Nuclear Safety with equipment for a nuclear protection system as well as an accountancy and control system with the cooperation of the USA, Sweden and the IAEA.

Japan supplied equipment, including vehicle maintenance equipment and computers, to the vocational retraining centre for ex-military personnel to promote the re-employment of former soldiers who had been discharged as their strategic nuclear missile force was disbanded.

4. CONCLUSION

As I have shown, Japan's cooperation activities have focused on capacity building in nuclear security measures and provision of necessary equipment. However, necessary legal infrastructure in the countries concerned should also be well established to address nuclear security. In this connection, it is imperative that more countries ratify the International Convention for the Suppression of Acts of Nuclear Terrorism. Having ratified the Convention recently, Japan sincerely hopes that those countries that have not yet done so will ratify the Convention as soon as possible.

As the current 'nuclear renaissance' progresses, nuclear security will become more important than ever. While centring its efforts on the Asian region, Japan is determined to work with the international community to strengthen nuclear security and threat reduction efforts in other regions to the extent possible. We are convinced that this meeting will be fruitful and one where all of us can gain important insights in our future endeavours.

Thank you very much.

ILLICIT TRAFFICKING AND NUCLEAR TERRORISM

(Session 1)

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INDICATORS AND WARNINGS
A framework for assessing the threat

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Abstract

The paper examines the utility of an 'indicators and warnings' framework for thinking through and responding to the associated threats of nuclear trafficking and nuclear terrorism in the context of "a possible international strategy to prevent, detect and respond to this phenomenon." The production of accurate and timely intelligence on these twin problems is obviously of central importance to all national, bilateral and multilateral responses designed to mitigate the threats posed in this area. A single and coherent "international strategy to prevent, detect and respond" to the threat posed by nuclear trafficking and terrorism would certainly benefit from a common approach to the assessment of information and the generation of intelligence assessments and warnings. It is against this backdrop that the paper examines the utility of an indicators and warnings framework for thinking about the associated problems of nuclear trafficking and terrorism. The paper also addresses some of the challenges and problems associated with generating accurate indicators and warnings.

1. INTRODUCTION

This paper examines the utility of an 'indicators and warnings' framework for thinking through and responding to the associated threats of nuclear trafficking and nuclear terrorism. The rationale for the paper is firmly rooted in the conference's stated purpose and objectives, specifically the goal of considering "a possible international strategy to prevent, detect and respond to this phenomenon". Although it is unclear whether it would be politically feasible to devise a single and coherent 'international strategy', the term 'strategy' in this context could be defined as a plan of action, or a 'prudent idea or set of ideas', for utilizing all instruments of power and influence available to the international community "in a synchronized and integrated fashion", with the goal of preventing illicit nuclear trafficking and the terrorist acquisition and use of nuclear and radioactive materials This definition was derived in part (with directly lifted elements in quotations) from the definition of 'strategy' used in Ref. [1].

At the heart of this 'strategy' is the relationship between 'ends' (goals) and 'means' (e.g. diplomatic, political, economic, law enforcement, intelligence, science and technology, military). Of course, several relevant international instruments, or 'means', of a 'possible international strategy' are already in place and include the Convention on the Physical Protection of Nuclear Material (CPPNM) [2], the International Convention for the Suppression of Acts of Nuclear Terrorism [3], the Code of Conduct on the Safety and Security of Radioactive Sources [4], the Guidance on the Import and Export of Radioactive Sources [5], the United Nations Global Counter-Terrorism Strategy [6] and United Nations Security Council Resolution 1540 [7]. These United Nations centric approaches are further underpinned by international cooperation at the bilateral level between States, within regional organizations such as the European Union, and at the multilateral level outside of the United Nations framework, such as through the Proliferation Security Initiative and the International Technical Working Group.

The production of accurate and timely intelligence is obviously of central importance to all national, bilateral and multilateral responses designed to mitigate the threats posed in this area. Anti-terrorism and anti-proliferation practitioners in national governments, as well as in international and regional organizations, rely on such intelligence to make informed judgements about the nature of terrorist and proliferation threats. These judgements are made at the strategic, operational and tactical levels, and involve the identification and assessment of relevant indicators to produce assessments and warnings to guide national and multilateral decision making.

A single and coherent "international strategy to prevent, detect and respond" to the threat posed in this area would certainly benefit from a common approach to the assessment of information and the generation of intelligence assessments and warnings. It is against this backdrop that the paper examines the utility of an indicators and warnings framework for thinking about the associated threats of nuclear trafficking and terrorism.

The paper is divided into two principal parts. The first part examines the use of an indicators and warnings framework for approaching the related problems of nuclear trafficking and terrorism. Part two then considers the challenges and problems associated with generating accurate indicators and warnings, and provides some illustrative examples from the field of trafficking and terrorism. A short conclusion summarizes the findings at the end. The aim is not to offer a detailed examination of nuclear trafficking and nuclear terrorism. Rather, the focus is on offering a perspective on how one particular framework is applicable to generating knowledge and understanding in these related fields. It should be noted that the research for this paper was based purely on open source materials.

2. INDICATORS AND WARNINGS

Indicators and warnings have been described as “the ‘bottom line’ of intelligence” [8]. Indicators (indications) can be defined as observables or activities related to a particular threat or challenge that can contribute to the generation of assessments and warnings to be fed into the decision making process [9]. Such indicators can focus on the capability element of the threat equation or on intentions. ‘Warning’ itself is “a process of communicating judgements about threats … to decision makers” and, to be effective, “communications must be received and understood in order for leaders to take action.” Thus, “effective warning … involves both communication and timeliness” [10]. Moreover, as Grabo has noted, “‘more facts’ and first-rate sources do not necessarily produce ‘more warning’ and intelligence warnings are useless unless some action is taken on them” [11].

Writing about the post 11 September 2001 world, where the focus has shifted away somewhat from assessing relatively straightforward threats associated with the military capabilities and political intentions of State actors towards assessing more complex threats such as international terrorism, Ermath has argued that the application of an “effective indicators and warning system” can still contribute to deterring actions and generate confidence in responding to threats, including the avoidance of overreaction. He breaks down the concept of warning into three levels:

(a) At the strategic level, warning focuses on “determining who the enemy is and what his capabilities are”;
(b) Operational warning focuses on “the enemy’s modes or operations of attack” and how these can be detected “before being put into action”;
(c) Tactical warning focuses on warnings that an adversary “is executing his attack plans” [12].

A significant level of complexity is involved when seeking to generate accurate and timely assessments and warnings in the related fields of nuclear trafficking and terrorism. The complexity is due primarily to the sheer multiplicity of the actors and factors that must be taken into account at the strategic, operational and tactical levels. Moreover, trafficking and terrorism are constantly evolving phenomena and do not stand still for long. As Clark noted on the subject of warning, “the world itself is a chancey and uncertain place, in which change, sudden or gradual, is more the rule than the exception” [13].

In general terms, the types of actors that appear to be the main focus of attention in this field include criminal groups and networks involved in the trafficking of illicit contraband; individuals (e.g. employees, officials) working at installations where target materials are located or who may be in a position to facilitate their theft or subsequent shipment from the point of origin and potentially across national boundaries to the point of destination; and terrorist groups and networks that might want to acquire and use such materials. These actors can be expected to have different motivations, intentions, tolerances for risk, geographical locations, areas of operation and so on.

The focus of indicators and warnings at the strategic level is on generating, maintaining and revising knowledge, and therefore understanding, related to the motivations, intentions and general capabilities of specific groups, individuals and even States of concern. In the realm of nuclear and radioactive materials, the question is not about what or how is trafficked or potentially used by a recipient. Rather, the focus is on questions such as whether or not sufficient incentives exist for the various actors to become, or to remain, involved in a particular activity relevant to the security problem at hand; it is about generating indicators related to the probability of involvement [11] in nuclear trafficking, in terrorism, or in both actitivties, as opposed to indicators related to specific activities at the tactical level.

The probability of involvement will be influenced by a number of variables for each specific group or the individuals therein. Examples of such variables may include the ways in which costs and benefits are calculated: “Are they ‘risk prone’ or ‘risk averse’, and do they think in terms of ‘minimizing losses’ or ‘maximizing gains’?” Moreover, “To what extent are they motivated by survival, security, recognition, wealth, power or accomplishment?” [14]. At the strategic level, it also needs to be recognized that the incentives for the various individuals and groups to become or to remain involved in a particular field will change over time. During the Cold War, for example, as Hulnick has noted, a major focus of strategic warning was on understanding what might happen [15]. This focus would appear to be just as relevant, if not more so, in today’s uncertain, unpredictable and ambiguous security environment, typified by the proliferation and terrorism challenges.

The focus of indicators and warning at the operational level is on generating, maintaining and revising knowledge, and therefore understanding, related to the preferred methods or patterns of operating (modus operandi) associated with the various actors that have been, are currently or may in future become involved in this area. A key emphasis here is obviouly on the trafficking methods favoured by criminal groups and networks, and their geographical area of operations at the local, national, regional and inter-regional levels. As has been seen in the field of nuclear trafficking since the end of the Cold War, the preferred smuggling routes of traffickers are likely to change over time whether in response to national or international measures aimed specifically at countering the problem, or potentially in reaction to unrelated developments that could potentially be opportunity driven.

The focus at the tactical level is on assessing indicators that can generate warnings related to specific events or activities. In many respects, of course, this is the real nub of the challenge in the field of trafficking and terrorism. It is important to remember, however, that the acquisition of information and the generation of tactical indicators related to suspect activity is likely to be directly influenced by assessments and warnings generated at the operational level, for example, an understanding of preferred modus operandi can help to target intelligence collection to look for particular types of activities and developments in specific geographical locations. In the trafficking field, tactical indicators could relate to plots or actual thefts or sales of material as well as shipments from the point of origin to a recipient. On the terrorist side of the equation, it could involve the disappearance of a particular operative, or heightened operational security on the part of a terrorist cell, which may indicate that something specific is beginning to unfold [9].

A quick look at the evolving challenge posed by nuclear trafficking highlights the benefits of an indicators and warnings framework. At the operational level, for example, the trafficking phenomena in the early 1990s appear to have been dominated by the shipment of nuclear and radioactive materials from the former Soviet Union to European countries. As Zaitseva notes, destination countries including Germany, Austria, Italy, Poland and the Czech Republic were targeted by smugglers in search of a market for their illicit merchandise [16].

From the mid-1990s, there was a drop in the number of recorded incidents and significant shipments, and this probably occurred as a result of smugglers being dissuaded by the fear of apprehension or because they realized that police sting operations may have simply created the impression that a market existed within Europe. A parallel development during the second half of the 1990s involved a geographical shift in the preferred trafficking routes from the former Soviet Union. As Zaitseva highlights, the focus moved to routes through the Caucasus, Central Asia, Turkey and the Balkans to the Middle East and south-west Asia. The change in direction appears to have been based, at least in part, on a desire to use more secure routes [16]. Maintaining and revising knowledge, and therefore understanding, related to such preferred methods of operating, and how they are likely to change over time and in response to what types of developments, is pivotal to directing actions at the tactical level designed to interdict illicit shipments. There is always the risk, of course, that anti-trafficking actions implemented at the tactical level could prompt a change in operating patterns on the part of traffickers that become much more difficult to identify and, therefore, to monitor in the future.

An indicators and warnings framework is also particularly relevant when shifting focus to actors that might contemplate using nuclear or radioactive material for terrorist purposes. International concerns about the potential acquisition and use of nuclear and radioactive materials by non-State actors are placed into sharp relief when we take into account strategic level indicators based on past events, actions and leadership statements associated with Al Qaeda affiliated individuals and groupings. In general terms, the goals of Al Qaeda could best be described as ‘total’ rather than ‘limited’ in nature, and hence there appears to be insusceptibility on their part to negotiations over a political agenda. When this is taken into account with the known interest and previous attempts of Al Qaeda affiliated groups to obtain and use unconventional weapons, then their willingness to acquire and potentially use nuclear and radiological materials is more than evident.

One step down the ladder, at the operational level, international anxieties are placed into further context by the modus operandi of Al Qaeda affiliated groups, notably the trend towards increasingly lethal terrorist events over the past ten years; an apparent preference for suicide operations; a lack of restraint with actions designed to have ‘mass effect’ (mass casualties, destruction and disruption); a lack of warnings; a preference for economic and transportation (air, surface and maritime) targets; and a history of launching concurrent attacks. The major area of uncertainty appears to be on the ‘capability’ level and the question of whether or how terrorist groupings will cross the requisite technical thresholds. This places into clear perspective the centrality of acquiring tactical level information on terrorist procurement of the necessary materials and technical knowledge.

Given the multiplicity of actors involved in the related fields of nuclear trafficking and terrorism, an integrated approach to considering indicators and warnings at the strategic, operational and tactical levels would appear to be desirable. At the strategic and operational levels, for example, an integrated and synchronized approach could assist in identifying whether the incentives, intentions and operating practices of specific actors currently, or may potentially, converge with one another in the field of nuclear and radioactive materials trafficking.

In summary, then, there are some evident advantages to utilizing an indicators and warnings framework for thinking through the nature of the threats posed in this field and how to counter them whether the focus at this level is on interdiction or deterrence/dissuasion. This would certainly appear to be the case in terms of the various levels — strategic, operational and tactical — at which the threats need to be examined. Such an approach helps to deconstruct the inherent complexity of the issues involved and can assist in keeping track of what is a constantly evolving threat picture. Moreover, the utility of such an approach is equally as relevant for dealing with classified or restricted material as it is for dealing purely with the collection and analysis of open sources.

Despite the advantages outlined above, it is also important to flag up some inherent challenges and potential problems. The next section seeks to cast light on some of these issues.

3. CHALLENGES AND POTENTIAL PROBLEMS

The challenges and potential problems examined below revolve around several themes ranging from those associated with complexity, opportunity and change, to a recognition that errors in the indicators and warnings field can result from such things as deception measures, or pre-existing viewpoints or positions on the part of analysts and decision makers. On this latter point, one result can be the marginalization of certain types of information or assessments if they do not support a prevailing opinion or policy objective.

Writing in the 1960s about warning and surprise in the context of the Cold War, Clark argued that several things can hamper the acquisition of solid indicators to produce assessments and warnings for decision makers. Firstly, there is "the sheer impossibility of keeping track of the moves of every individual, organization or government that may be in a position to change things in some part of the world" [13]. As discussed briefly in the previous section, the complexity of the trafficking and terrorism business is certainly a testament to the continued applicability of this observation because of the numerous types of 'actors' involved in the field.

Secondly:

> "Some events cannot be predicted because the principals seize sudden opportunities to act or are reacting to sudden stimuli, unforeseen and quite often unforeseeable by those on the spot. If the participants themselves could not have predicted the turn of events, the most sensitive and pervasive of intelligence systems would not be likely to do better" [13].

Although it is not in the nuclear field, a relevant example of a non-State actor seizing a sudden opportunity in the field of unconventional weaponry is an attack in 1990 by the Liberation Tigers of Tamil Eelam (LTTE) in which they used chlorine gas against a fort belonging to the Sri Lankan armed forces. This one-off event for the group was driven by the fact that it was running low on conventional weapons and the opportunity that was presented by the presence of chlorine containers at a local paper mill. Notably, the LTTE have never again used such materials [17].

Thirdly, as noted in the previous section, “the world itself is a chancey and uncertain place, in which change, sudden or gradual, is more the rule than the exception” [13]. Indeed, the relatively rapid dissolution of the Soviet Union resulted in a significant growth in international concerns about nuclear security in the former Soviet republics and the related threat of nuclear trafficking. Sudden changes can potentially be brought about by crises within States where the control of nuclear and radioactive materials may already be an issue or could potentially become a problem if political stability is undermined in any way.

In terms of indicators and warnings, the challenge becomes one of forecasting where around the globe we are likely to witness sudden or gradual change that could potentially influence the twin problems of nuclear trafficking and terrorism; one question is where will ‘weak’, ‘failing’ or ‘failed’ States present greater opportunities for criminal groups and terrorists to gain access to, or to smuggle, nuclear and radioactive materials? An example here may be the reports of the increased involvement of African nationals in the trafficking of radioactive materials. To what extent has Africa become a source of nuclear and radioactive materials as well as a smuggling route of increasing significance? [16].

In addition to challenges and problems stemming from complexity, opportunity and change (sudden or gradual), it is important to highlight several potential sources of error in the indicators and warnings field that can stem from the target itself, the analyst or the end-user of intelligence assessments. Error in this context may come in the form of faulty assessments and estimates or the rejection of information and/or assessments that do not ‘fit’ pre-existing viewpoints or policy priorities.

To begin with, deception may be used to conceal illicit activities whether these relate to the theft, smuggling or planned terrorist use of specific materials. As Lockwood notes, deception measures can be implemented in order to “deceive intelligence gathering, analysis and prediction” [18]. Moreover, as Davis noted during the Cold War, an important question here is whether the target’s “actions signify an effort at deception and is he deliberately, or perhaps unintentionally, creating a mix of signals that point in virtually opposite directions?” [19]. The problem here, then, is that deception can be both deliberate and inadvertent in nature, thus adding a further layer of complexity to an already multivariate threat picture in terms of the range of actors and factors at play in the trafficking and terrorism areas.

There is also the potential problem of analysts being, or becoming, susceptible to 'mirror imaging' which has been described as a "tendency to project one's own logic and mindset onto that of the opponent." In so doing, insufficient attention may be given to divergent cultures, value systems, frames of reference and technical abilities, and how these can influence motivations, intentions, patterns of behaviour and progress in attaining certain types of capabilities [18].

Although there is not enough material available in open sources to reach a definitive conclusion, one potential example involves US intelligence assessments of the Libyan Arab Jamahiriya's progress in the nuclear field prior to December 2003. In this case, it appears that overestimation of the country's progress towards a nuclear weapon capability may have been influenced by analysts viewing Libyan Arab Jamahiriya's significant procurement activity from the late 1990s through a lens which did not take into account the realities on the ground in Libyan Arab Jamahiriya at the technical, economic and political levels. The resultant assumption, based purely on indicators related to procurement activities, was that significant progress must have been made in Libyan Arab Jamahiriya because of the major infusions of equipment and materials which were made possible by outside assistance [20].

Another potential problem involves 'received opinion' which can result in a resistance to change a particular viewpoint even 'in the face of contradictory evidence'. This can lead to information being excluded if it does not 'fit' the accepted, prevailing or 'conventional wisdom'. Lockwood argues that received opinion can make analysts vulnerable to deception whether "self-induced or induced by the enemy" [18]. In the area of nuclear trafficking and terrorism, the most likely problem in this respect may be the risk that new trends, such as changes to modus operandi or the emergence of new and influential 'actors', may not be picked up particularly quickly if the relevant evidence does not fit neatly with previously observed patterns of behaviour associated with particular issues.

Because gradual or sudden change should be viewed as inevitable in this field, then maintaining an awareness of how 'received opinion' can influence analysis and decision making is an absolute must. As Clark noted, "intelligence has the responsibility to keep its consumers sufficiently aware of the remoter contingencies" and "the relevance of the less obvious" [13]. Indeed, it is not difficult to grasp how received opinion could potentially undermine this important task and also make analysts "a victim of the Easy or Logical Explanation Syndrome" [19].

Admittedly, however, Clark also noted that it is important that the 'senses' of intelligence users are not dulled, and their patience is not stretched, with "frequent laundry lists of all imaginable horrors" [13]. As Davis emphasized, it is important to "remember that repeated warnings can dull the reactions and wariness of both the policy-maker and the intelligence analyst" [19]. Grabo noted that, the 'cry wolf' syndrome benefits no one because "false alerts, and particularly a series of them, breeds scepticism or downright disbelief of the authentic warning when it is in fact received" [11]. The watchword here, therefore, is 'selectivity' which has been described as "a cardinal principle of effective warning intelligence" but which "involves rejection, and rejection involves risk" [13].

Decision makers can also contribute directly to errors, particularly in situations where there is an existing predilection for accepting intelligence findings that support a specific priority or viewpoint; one potential outcome in this respect may be that accurate intelligence is disregarded if it is not seen to be supportive of an existing priority or viewpoint [18]. One potential example from the field of nuclear and radioactive materials trafficking might be the use of sting operations in Germany primarily during the first half of the 1990s where the security services posed as buyers in order to apprehend traffickers but in the process actually 'instigated the smuggling' in the first place. Indeed, as Zaitseva notes, these sting operations "apparently had a local political agenda" [16].

Finally, given the scale of the stakes for criminals involved in the trafficking of nuclear and radioactive materials, particularly if they are working to order for a terrorist group, it is quite likely that no indicators may be detectable and therefore actionable in an interdiction sense. This likelihood appears to be evidenced by the debate among academics and other non-governmental specialists over the extent to which criminal and terrorist networks have already or may potentially cooperate in the nuclear trafficking area — this debate itself is influenced significantly by the limited evidence base in open sources [16, 21].

4. CONCLUSION

As noted in the introduction, this paper does not aim to offer a detailed examination of nuclear trafficking and terrorism, and it focuses instead on offering a perspective on how one particular framework is applicable to generating knowledge and understanding of these related phenomena.

Anti-terrorism and anti-proliferation practitioners rely on accurate and timely intelligence to make informed judgements about the nature of terrorist and proliferation threats at the strategic, operational and tactical levels. This involves the identification and assessment of relevant indicators to produce assessments and warnings. In the context of “a possible international strategy to prevent, detect and respond to this phenomenon”, this paper seeks to highlight the utility of an ‘indicators and warnings’ framework for thinking about the twin problems of nuclear trafficking and nuclear terrorism at the strategic, operational and tactical levels. It has been suggested that such an approach should help to deconstruct the inherent complexity of the issues involved, and can assist in keeping track of what is a constantly evolving threat picture.

The paper also illustrates the challenges and potential problems associated with producing accurate and timely assessments and warnings for decision makers to act upon. The challenges and potential problems are a direct result of the complex nature of the phenemona under examination based on the multiple actors involved, the inevitability of change whether sudden or gradual in nature, and the ‘opportunity factor’ which makes trafficking and terrorism difficult to forecast. Of course, traffickers and terrorists can also implement deception measures to capitalize upon all of this complexity. There is a further concern worth highlighting and this involves the risk that pre-existing viewpoints or positions on the part of analysts and decision makers could potentially lead to certain types of information or assessments being sidelined if they do not support a prevailing opinion or policy objective.

Against this backdrop, there would appear to be a requirement to further develop multilateral threat assessment and warning capabilities in order to inform decision making and resource allocation processes at the national and international levels. Given the constraints imposed by the sensitivity of national governments to sharing national intelligence beyond trusted allies, one concrete move in this direction would be to place an increased emphasis on the collection and analysis of open sources at the multilateral level, particularly original language materials and sources that are not necessarily available on-line. One option here could be to continue investing resources and developing the already well established use of open source research and analyis at the IAEA.

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FIGHTING NUCLEAR SMUGGLING IN THE EUROPEAN UNION*

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STRENGTHENING BORDER CONTROL AND MANAGEMENT

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Abstract

The world has experienced monumental changes in recent years. Globalization has brought many benefits. Business and commerce have increased and, as a result, brought us cheaper, more accessible goods from all regions of the world. We have access to relatively cheap and certainly much easier travel. We now live in a world of instant communications with mobile phones, laptops and 'BlackBerries'. However, there is a downside to globalization — transnationally organized crime and the reality of terrorism have grown. As more people cross borders, it is harder to detect criminals and terrorists. In the European Union, the internal borders of the now 27 member States have been dismantled. Effective international measures to counter organized crime and terrorist groups are of crucial importance. It is important to think globally and to act locally. The paper looks at some of the crime challenges and provides insight into the role and work of the United Nations Office on Drugs and Crime (UNODC) in drugs and crime control. It focuses on border control initiatives conducted by the UNODC.

Firstly, a little about the United Nations family. It includes many organizations that you will be familiar with and perhaps others that you will not. The United Nations deals with a wide range of activities including humanitarian, environmental, health, development and peacekeeping. The organization also plays a role in combating organized crime, drug trafficking and terrorism.

There are different factors that create an environment where crime can flourish (such as corruption, lack of economic opportunities, poverty, limited State capacity, weak and porous borders, limited cross-border cooperation) and which present serious challenges to the international community. Well developed routes for smuggling drugs are also used to smuggle people, firearms and other forms of contraband — also nuclear and radioactive material. The degree to which the problem of transnationally organized crime has become a truly global phenomenon during the past decade or so is remarkable. Porous borders and weak border controls contribute to the problem. Corruption is often at the root of many of these crimes.

One of the major challenges we face is to understand more accurately the problem in all of these illicit markets. This is one of the major planks of UNODC work. To effectively counter the problem of organized crime at the national, regional and international levels requires an enhanced capacity to collect and interpret the available data. This will allow policy makers to make informed strategic choices, particularly in the deployment of resources.

In particular regarding terrorism, the link with organized crime is extremely difficult to quantify. It is an undisputed fact that terrorist groups need money to buy weapons, explosives and generally finance their operations. Their activities often include major involvement in actual drug production and trafficking. Some are even known to 'tax' drug producers and traffickers. Here are some examples:

— In Central Asia, the Islamic Movement of Uzbekistan (IMU) is a major actor in drug trafficking with links to Al Qaeda;
— In Colombia, the activities of the Revolutionary Armed Forces of Colombia, known as FARC, in cocaine production and trafficking are well known;
— In the Kurdish areas of Turkey and Iraq, there are strong indications that the Kurdish Worker's Party or PKK is involved in the trafficking of opiates.

Border management and control is of particular importance for the interruption of trafficking routes and holds particular relevance to the operations of the UNODC.

Let us examine for a moment the case of Afghanistan. In accordance with the UNODC's 2007 World Drug Report, Afghanistan produces 92% of the world production of opiates. Most of the heroin and morphine seizures remain concentrated in the countries around Afghanistan and in the main transit countries to Europe. Many of these illicit consignments are trafficked through the Islamic Republic of Iran, through Turkey and countries along the Balkan route in south-eastern Europe. Other routes from Afghanistan are the northern route through the central Asian States to the Russian Federation and south through Pakistan. As regards the modus operandi used for trafficking heroin, transport by road continued to be the most frequent for large quantities.

The main precursor chemical involved in the manufacture of morphine and heroin is acetic anhydride. A substantial part of the opiates produced in

Afghanistan is refined inside that country into heroin and morphine. Afghanistan is not a producer or legitimate user of acetic anhydride, so large consignments of acetic anhydride and other chemicals are smuggled into the country. The following are examples of concealments:

— The first examples relate to a seizure in Turkey where the acetic anhydride was concealed in a consignment of timber. This method has also been used in other regions, with a similar case uncovered between the Russian Federation and Turkey.
— The second example illustrates the smuggling of 9 t of acetic anhydride seized in Bulgaria. Plastic containers containing the acetic anhydride were concealed in hollowed out air conditioning units.

These examples indicate a high level of planning, organization and professionalism on the part of the criminals.

Having briefly spoken about some of the challenges we face, I will now turn to the role and work of the UNODC. The UNODC is mandated to assist the 192 United Nations Member States in their efforts to combat the problem of drugs, organized crime and terrorism. We promote international cooperation, particularly between law enforcement agencies. This is an ambitious and idealistic mission statement but something we must strive for. In the context of capacity building to combat illicit drug trafficking and transnationally organized crime, our programme has worked with governments in all regions of the world in this specialized area for more than 15 years. The knowledge base we have developed in this field and the skills imparted through our interventions are now being brought to the broader fight against cross-border organized crime.

UNODC technical assessments conducted in various parts of the world highlight the need for assistance in many areas, particularly in law enforcement. Some of the main problem areas are:

— Ineffective border controls;
— Lack of any real strategy or operational focus;
— Poor inter-agency cooperation;
— Inadequate systems for intelligence gathering, analysis and use;
— Reluctance to share information between agencies;
— Corruption;
— Lack of effective cross-border/regional/international cooperation;
— Lack of equipment;
— Lack of trained staff and expertise in specialist areas;

— Need for legislative assistance — inability to investigate and recover proceeds of crime.

The UNODC has developed over 230 technical assistance projects, including some quite unique and innovative responses in capacity building:

— A benchmarked standard of training for frontline officers in our computer based training programme;
— A border liaison programme offering an effective blueprint for cooperation and coordinated control at common borders;
— A comprehensive anticorruption toolkit for governments;
— The establishment of regional information and coordination centres to support real time operations by the regions' law enforcement agencies;
— The Paris Pact Initiative, a move to reverse the compartmentalized approach of donors, stakeholders and assistance providers to drug related threats and bring coordination and focus to their efforts.

Let us examine some of these programmes more closely:

(a) *Border control:* The UNODC is implementing several projects for the strengthening of border control mainly in central Asia, south-east Asia and Africa. They include:
   (i) Reinforcing drug control capacities at five airports in each central Asian State;
   (ii) Enhancement of drug law enforcement training in central Asia (F60) through computer based training;
   (iii) Strengthening drug and related crime control measures in selected checkpoints in Kazakhstan and multi-agency border teams in Kyrgyzstan;
   (iv) Establishment of border liaison offices in six south-east Asian countries;
   (v) Creation of specialized, joint port control teams in several ports of eastern and southern Africa;
   (vi) Countermeasures against illicit drug trafficking and cross-border crime along southern and east African land borders.

   An example of a challenge faced by UNODC is the project for the strengthening of Afghanistan–Iran drug border control (SAID). The project will seek to establish and then equip 25 border control points along the mutual border in the provinces of Herat, Farah and Nimrah. Support will include communications equipment, vehicles, search equipment and joint training.

(b) *Training of law enforcement and border control personnel:* The UNODC also provides specialist training for law enforcement officers, including:
   (i) Planning and implementation of specialist operations;
   (ii) Investigation of major crime, gathering/preservation and use of evidence;
   (iii) Mobile and static surveillance;
   (iv) Covert intelligence gathering;
   (v) Undercover operations — use, management and control of informants;
   (vi) Technical/electronic evidence gathering;
   (vii) Interview skills;
   (viii) Computer based training.

   Training is often followed with the provision of essential equipment: radio communications equipment, mobile phones, vehicles, motorcycles, binoculars, night vision equipment, narcotic and precursor test kits and computers.

(c) *Regional law enforcement cooperation:* A key issue is improving cooperation and intelligence exchange between law enforcement agencies, particularly at the cross-border, regional and international levels. The UNODC is currently carrying out two major projects to improve regional law enforcement cooperation and coordination:
   (i) Central Asian Regional Information and Coordination Center (CARICC);
   (ii) Gulf Centre for Criminal Intelligence (GCCI).

   In Central Asia, the CARICC project has been designed with the objective of developing regional cooperation between the law enforcement bodies of the five central Asian States (Uzbekistan, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan), Azerbaijan and the Russian Federation in the fight against transnational organized crime related to illicit drug trafficking. A similar centre is being established in the Gulf region with the participation of Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates. Both these centres will be linked to Europol, the World Customs Organization (WCO), INTERPOL and the SECI Regional Centre for Combating Transborder Crime in south-east Europe.

(d) *Container control programme:* Finally, in a joint initiative with the WCO, the UNODC has developed and is implementing a container control programme. The programme aims at strengthening procedures to prevent containers being used to smuggle drugs and other forms of contraband. It includes assistance for the establishment of joint port control units from customs, police and port authorities, as well as training by international experts and mentor services.

The programme initially included four countries, namely Ecuador, Senegal, Ghana and Pakistan. It has led to improved cooperation between law enforcement agencies and port management, more effective risk profiling and success in making significant seizures of cocaine and other forms of contraband, especially in Ecuador.

The focus of this meeting is the illicit trafficking of nuclear material. Container security and stricter border controls are essential elements in our overall preventative strategy. Another element is working closely with other partners to ensure a unified response that maximizes the impact of international assistance. In conclusion, I would like to thank you for the opportunity to address you today and would like to wish you a very successful meeting.

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FEARS AND CONCERNS — THE PUBLIC PERCEPTION

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Abstract

The terrorist attacks of 11 September 2001 took place more than six years ago and happened far away, but for many people, time and distance simply cannot push aside the danger they represent. A study published by one of Germany's major insurance companies shows that public fears with respect to terrorist attacks rose in 2007 compared with 2006. With respect to nuclear terrorism, the expectation is that there is no overwhelming concern since there has been no nuclear attack so far. As it turns out, however, the contrary is true. The paper discusses how to deal with the public perception of nuclear terrorism, and ponders what the best strategy would be.

A study published by one of Germany's major insurance companies shows that public fears with respect to terrorist attacks rose in 2007 to 50%, compared to 41% in 2006. One in two Germans believes that a suicide bomb attack in one of the country's cities is a bigger personal threat than, for example, losing his or her job. In Berlin, as the nation's capital, even 61% fear that they will witness some form of terrorist action in the near future, which could have a major impact on their daily life.

I think that the results of such an inquiry would be similar everywhere as soon as a threat becomes concrete. In Germany, we had two failed suitcase bomb attacks in late July 2007 and, weeks later, we witnessed the arrest of three suspects who were apparently engaged in the preparation of very powerful chemical bombs. Following this, another suspect was arrested. All the suspects were converted Muslims. The public perception has changed dramatically since this event. Now the thinking is more along the lines of — yes, we might also be hit; yes, we are being targeted by Al Qaeda; and, yes, we cannot ignore the threat any longer. The events of 11 September 2001 took place more than six years ago and happened far away, but for many people, time and distance simply cannot push aside the danger they represent.

What about nuclear terrorism? The insurance study cited does not differentiate between a conventional attack or one with weapons of mass destruction — chemical, biological or nuclear — and I do not know of any inquiry which has specifically asked about the nuclear scenario. Some experience, though, comes from public discussion about the subject and the feedback I received after the transmission of my television documentary programmes and books which dealt with nuclear terrorism and especially the Khan network. The feedback is far from being in any way representative of public perception in Germany, but it still provides some ideas about how the risk is seen.

One would expect that there is no overwhelming concern, because luckily there has been no nuclear attack so far. As it turns out, however, the contrary is true, which may have to do with certain irrationalities, with a sense of certain instinctive, primeval fears about dangers you cannot actually see, smell or taste. 'Radioactivity' seems to be a synonym for 'silent death'.

Take 'dirty bombs', for example. Only a few people differentiate between the effects of a contaminated ordinary explosive, which is not a matter of very sophisticated technology, and those of a nuclear explosion, which is a very sophisticated technology. Radioactivity is generally seen as extremely dangerous. If a bomb exploded somewhere and merely a rumour spread that it was contaminated, it would cause panic within just a matter of minutes. People of my generation remember all these scenarios from the early days of nuclear power and the discussions about evacuation plans, panic ridden crowds flocking to the streets and general chaos. We even remember the time after the Cuban crisis and during the Cold War, when a Soviet nuclear attack seemed possible, and instructions were given from government scientists: in the event of a nuclear explosion (they told us) — no matter how far away you are, you should still take precautions by placing your briefcase on top of your head as an umbrella to protect yourself against the nuclear fallout. So, what would happen in the case of a confirmed 'dirty bomb'? As one viewer asked, would it be a good idea for the government to hide the fact that radioactive material had been released? Frankly, I do not think that there is any way of concealing it, and rumours may simply be worse than the truth. On the other hand, if the truth was that the material involved only presented a low risk of radioactive contamination, would anybody actually believe it?

A single 'dirty bomb' would change everything and it is relatively easy to make one. So, why have Al Qaeda or other terrorists not tried to use them so far? There is the case of José Padilla, a 'home-grown' US terrorist, who had been convicted of preparing such a device (although he did not confess to the charges even after being kept in total isolation for two and a half years). We also have some bits and pieces of information that 'dirty bombs' may be on Al Qaeda's agenda. Others argue that terrorists want the 'big bang' effect with as many casualties as possible at the very instant of the explosion instead of a scenario of thousands of cancer victims and children with malformations months and years later. Who knows? However, are we really sure what terrorists want? And would spreading panic not be an effective tool for those who want to demonstrate how supposedly weak and inferior our society is?

What about using nuclear power plants? The Chernobyl accident occurred more than 20 years ago. Most people can still remember that they were recommended not to eat vegetables from their own garden or mushrooms from the forest in the years following the disaster as they may have been contaminated by the radioactive cloud passing over Europe, even though Chernobyl was more than 1500 km away. Nuclear power may be a relatively safe form of energy, but the single event of Chernobyl did show that risk tends to be defined in terms of two factors: the probability of fatalities and the amount of horror or disgrace it can cause. The first is small, the latter huge. So, what if terrorists crashed a plane into a nuclear facility? The attacks of 11 September 2001 revealed how interested Al Qaeda terrorists were in attacking the Indian Point power plant. The hijackers of American Airlines flight AA 11 used the Hudson River below to guide them directly to Manhattan and the World Trade Center. Mohammed Atta, the pilot of flight AA 11, who had checked out the possible targets during reconnaissance flights, viewed Indian Point as an interesting option. Finally, the group decided against it, however, because the terrorists thought that any plane would be shot down before impact, and that targeting a nuclear facility would not have the symbolic value of the World Trade Center. However, ‘plan B’ could eventually become ‘plan A’ in Al Qaeda’s long term strategy.

Months later, the German authorities launched a secret experiment with six amateur pilots with the same level of training as that which the 11 September 2001 terrorists most likely had. The experiment took place using a flight simulator at the Technical University in Berlin. The task was to crash their virtual planes into the virtual German nuclear power plants on the screen in front of them. They had a 50% success rate. At least 11 of the existing 18 reactors in Germany would have been destroyed by an airplane crash, some even by a small Boeing 737.

When I presented the results of the experiments, the public’s reaction was surprisingly not as I had expected. Apart from explosions with nuclear contamination or fissile material, an attack on a nuclear power plant seems to be a distant concept in the public’s imagination. The nuclear industry was reluctant to confirm that most of its facilities are very vulnerable. It first tried to ignore the problem, and then suggested a countermeasure — which again seems something rather a long way off — namely, to install an artificial fog system within the power plant, which would be activated within milliseconds of a plane entering a secure zone. The fog would then blur the terrorists’ view of their target shortly before impact. This was the idea back then, and the fog concept is now currently being used as part of a series of tests at one of the nuclear plants.

Another possible approach was to build huge steel towers around the power plants as a form of physical protection. Finally, the legal and moral implications of a new law were discussed to allow the military to shoot down an airplane shortly before it crashed into a reactor containment. However, should this be done automatically or by someone pushing a button?

Finally, what about the most dangerous threat — a nuclear device in the hands of terrorists or a criminal organization, either to blackmail governments or to use as the ultimate weapon? Thinking the unthinkable: Islamic terrorists with no moral scruples would try to create another Hiroshima or Nagasaki. Documents found in Kabul after the invasion of US forces in late 2001 showed that a meeting had taken place in August that year between Pakistani nuclear scientists and some high up Taliban and Al Qaeda operatives. It obviously had only been a general course in nuclear physics, however.

What about the Khan network? The transfer of know-how and technology to Libyan Arab Jamahiriya, the Islamic Republic of Iran and the Democratic People's Republic of Korea led to the question of whether there were also shipments to Afghanistan under the rule of the Taliban? Moreover, is there an international black market not only for sensitive blueprints and equipment, but also for 'the stuff' itself — HEU or plutonium? Could the Khan network have supplied terrorists with enough HEU from its stocks for a single crucial gun barrel device or rogue insiders from the States of the former Soviet Union? Probably not, but again, would we be told the truth? There is a public perception about the possibility of selling the nuclear fire to everybody who pays and this has to do with the feeling that you can buy everything on Earth if you have enough money in your pocket. The story of A.Q. Khan and his greedy associates all over the world has proven that this is true.

Surprisingly, however, there is less public attention about what might be the most likely worst case scenario. Pakistan is in turmoil. This can be witnessed every day on the news. The nuclear arsenal of the country may one way or the other fall into the hands of extremists and terrorists. A Taliban-like regime, including those forces in the military who feel deep sympathy for their extremist philosophy, could take over command and control of the 40 or so nuclear weapons, which allegedly are stored in bunkers deep under the Kirana Mountains.

How could our governments deal with the public perception of nuclear terrorism? Is information about the risks and dangers a possibility? For a journalist, it is always easy to demand more information in order to enlighten the public. In the case of nuclear terrorism, however, I admit I am simply not so sure what the best strategy is.

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ILLICIT NUCLEAR TRAFFICKING
Collective experience and the way forward

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Abstract

Illicit trafficking and other unauthorized activities involving nuclear and other radioactive material are potentially indicative of weaknesses and vulnerabilities in measures to prevent illegal acquisition; of needs and priorities in detection and response measures; of the potential availability of material for malicious use; of the existence or perceived existence of illegal markets for nuclear and other radioactive material; and of the involvement of organized criminal and terrorist groups. Analysis and evaluation of data on illicit trafficking provide insights into these aspects and can, thereby, make a contribution to assessing risks and identifying potential threats, both in broad and specific terms. The paper draws upon information made available by States to the IAEA Illicit Trafficking Database; a system for collecting and collating, analysing and disseminating information on illicit trafficking and other unauthorized acts. Other inputs include indicators of the intentions and capabilities of potential perpetrators of malicious acts and an increasing understanding of the scope for malicious use of radioactive material and the potential consequences. Taken together, these insights provide a foundation for developing and prioritizing future measures to prevent, detect and respond to illicit trafficking, thereby enhancing nuclear security.

1. ILLICIT TRAFFICKING AND THE THREAT

'Threat' is a term often used loosely. The definition used in this paper includes situations where a perpetrator or intent is not identifiable but where other factors, primarily the availability of suitable nuclear or radioactive material, leads to the conclusion that there is potential for a malicious act. For example, if sufficient high enriched uranium (HEU) to assemble an improvised nuclear explosive device (IND) disappeared from a store, the loss would, and should, be considered a potential threat even if the circumstances are not known and there is no information on the identity of possible perpetrators and their intentions.

The IAEA claims no special insights or competence on the intentions or competence of terrorist groups or others with malicious intent; neither does it attempt to define them. Open sources are relied on to provide information on intentions. Fortunately — or perhaps unfortunately — on this issue, there is an almost global consensus, reflected in resolutions of the United Nations Security Council and General Assembly, that there is a real threat that terrorist groups are seeking to acquire nuclear and radioactive material and would use them for malicious purposes. This consensus is given further substance by a number of national security assessments issued by authoritative sources in States across the globe.

It almost goes without saying that the possibility that a terrorist group will acquire sufficient nuclear material suitable for constructing and detonating an IND is the greatest threat we face. The consequences if detonated in a populated area would be truly catastrophic in their immediate impact and would have far reaching and unpredictable future consequences. For this reason alone, measures to prevent such an event must be our highest priority. We cannot accept even a possibility that this might happen. We must, therefore, achieve the very highest standards in prevention measures.

But nuclear terrorism has other facets, not as destructive as an IND but also with far reaching and unpredictable consequences. Sabotage of a nuclear facility or transport could, in certain circumstances, produce a widespread radiological hazard; and the use of radioactive material in dispersal devices (e.g. 'dirty bombs') and other malicious applications have the potential to produce high levels of disruption, cost and distress. In these cases, the consequential economic and financial costs could be very high; measured in the modelling of possible scenarios in multiples of billions of euros.

Recent events, notably here in the United Kingdom, have added new insights into potential scenarios for nuclear terrorism. Papers drafted by Dhiren Barot and released at the time of his trial, show an understanding of the utility of radiological terrorism. He notes that they were primarily 'weapons of mass disruption, dislocation or effect' and that decontamination and rebuilding costs could be 'immense' "perhaps upwards of billions of dollars (sic)". Drawing upon the consequences of an accident in France involving 900 smoke detectors, he proposed burning or exploding a large number of smoke detectors (he suggests 10 000) containing ^{147}Am (sic). In his estimation, the "fear and chaos that this would spread would be large scale and on a long term basis (sic)." Barot recommended the use of smoke detectors because they were easy to acquire. We have other indicators of the potential disruptive effects and economic consequences of malicious use of radioactive material, most notably the Goiânia tragedy in Brazil, an accident which resulted in 250 people exposed to radiation of whom four died. Decontamination costs were substantial and over 100 000 people subsequently sought medical help from local hospitals.

The conclusion to draw from these events is that INDs and radiation dispersal devices (RDDs) are not the only potential scenarios for nuclear terrorism.

The unique place that radiation occupies in the public psyche — a place shared only with biological weapons — means the value of radioactive material for a terrorist may lie in their power to capture public attention, produce disruption and incur high economic costs.

2. ILLICIT TRAFFICKING

Stop people on the street and ask what they understand by illicit trafficking; among the elements which would come to their minds first are criminality, intent, some concept of quantity and movement across borders. Probe a little more deeply and they would probably also accept that the material does not have to be actually moving; illegal or unauthorized possession is enough. They would probably also accept that stealing, or otherwise acquiring material illegally, is included, that intent does not have to be known and that movement across an international border is not a necessary condition.

The scope of the definition is important because from the perspective of those of us dedicated to enhancing nuclear security, illicit trafficking is an indicator of potential risks and threats. But it is also a symptom; a symptom of failures or vulnerabilities in prevention and detection measures. If we are to pursue comprehensive solutions to the nuclear security threat; to move away from the 'Band-Aid' approach focusing on individual aspects of the problem, we need information which helps to identify needs and priorities; generic and specific weaknesses and vulnerabilities in accounting and control, physical protection and detection systems; information on routes, types of material, modus operandi and illicit markets, as well as information on potential threats.

This approach is reflected in the scope of the information collected by the IAEA's Illicit Trafficking Database (ITDB), now in its 12th year of operation and approaching the recruitment of the 100th participating State. Its scope is intentionally broad, extending beyond the narrow definition of illicit trafficking as is found in areas such as drugs or small arms. Developed in close consultation with the participating States and established in more or less its current form many years ago, the scope covers all types of radioactive material, all quantities and all unauthorized activities including thefts and losses, interdictions and recoveries, sales and attempted sales, unauthorized movements and disposals. By including all forms of unauthorized activities, the potential for making a real contribution to understanding the problem and identifying potential solutions is maximized.

The ITDB is not just a database. A better description would be to call it an information system which includes information dissemination and analysis, both regular and on request. This produces some interesting insights into the threat.

First, some general points about the scale of the problem. The ITDB currently contains information on 1266 incidents reported by States since 1993. Many more incidents have been reported in open sources but await confirmation or denial by the States involved. The number of incidents being reported each year has increased, for example, between 2002 and 2006 the number of reported incidents rose by 385%. But it must be emphasized that while this is evidence of a major problem, it is not necessarily one which is getting worse so quickly. Absolute numbers of incidents occurring may be increasing but other factors are at work in driving up the numbers reported to the database. For example, reporting by States has improved for a variety of reasons which include better control and inventory measures. National detection and interdiction capabilities have also improved. So the increase in numbers of reported incidents may, at least in part, be an indicator of success in efforts to improve security. It is also interesting to note that the number of States reporting to the ITDB has increased from 72 at the end of 2002 to 99 in 2007.

One other general point, absolute numbers have their attractions, especially to headline writers, but each incident reported to the ITDB also has an intrinsic significance for security which is related to the individual circumstances and the type of material involved. We are in the late stages of developing a methodology for assigning a value for 'security significance' of each incident reported. We intend to use this for internal analytical purposes first and, if IAEA Member States and others such as the media find it useful, we will extend its use. I would also point out that absolute numbers are less informative than patterns and trends.

3. TYPES OF MATERIALS

Let us start with the IND threat: incidents which involve weapons usable material: HEU or Pu are, in statistical terms, relatively rare. Only 18 incidents have been reported since the database began collecting information. However, this provides no grounds for complacency. Given the consequences of the detonation of an IND, any incident which involves material for such a device is of the highest concern. Some of the cases in the early 1990s involved kilogram quantities. We have not seen these amounts since; typically, cases have involved gram quantities in recent years. However, a worrying aspect is that some incidents are, or appear to be, linked: e.g. HEU seized in France and Bulgaria. This raises the possibility that the materials offered for sale and/or recovered, were samples drawn from larger caches which as yet are unrecovered. Alternatively, and equally worrying, is that linked cases are evidence of a weakness in security at the facility of origin which has already led to some thefts and may be exploited again.

The great majority of uranium cases reported to the ITDB involve LEU or source material. These materials are of little direct use in themselves and, as already noted, would require processing beyond the capabilities of a terrorist group to become so. However, they are symptomatic of failures or vulnerabilities in control and protection measures at the facility of origin — in some cases, such facilities may handle both HEU and LEU — and of detection and interdiction measures along the lines of movement. They are also indicative of the existence of an illicit market, perceived or real.

One piece of good news is that the number of incidents involving LEU reported to the ITDB has been declining since 1994. This appears to be an indication of the success of measures to improve security, in particular at fuel fabrication and storage facilities.

Radioactive sources involved in incidents range through all categories of material; from the ‘very dangerous’ to the ‘not dangerous’, according to the IAEA’s categorization scale. As already noted, the material suitable for malicious use can be extended if the desired consequences go beyond the deterministic, to include psychological, social, economic and other considerations unrelated to destructive power or even the power to contaminate. Of the 1266 incidents reported to the ITDB by States, 825 involved radioactive sources although the radioisotope involved, or its activity level, is not always known. Of those incidents where we have this information, one third involved ^{137}Cs sources usually in moisture density and level gauges, and in medical applications. The activity levels involved are usually not very high (hundreds of MBq to tens of GBq) and mostly, but not exclusively, Category 4 and 5 on the IAEA categorization scale. Even so, these ^{137}Cs sources have potential for malicious use either individually or through accretion. Of the remaining incidents, most of these are also Category 4 and 5 sources but include some more dangerous material, mainly ^{192}Ir and ^{90}Sr.

4. THEFTS, LOSSES AND RECOVERIES

A report of a theft or loss is evidence of a weakness or vulnerability in measures to control and secure such material. Analysis also shows that detection or recovery of nuclear and other radioactive material, whether in unauthorized possession, intercepted while being trafficked, or recovered by a roadside or in a load of scrap metal, involve material which has not been previously reported as lost or stolen. Assuming that States are assiduous in reporting thefts and losses to the ITDB, the logical conclusion is that national control mechanisms are inadequate because not all thefts and losses are being detected.

Analysis shows that material which has been reported as stolen or lost are, in the majority of cases, not recovered. Coupled with the evidence that some thefts and losses are going undetected, this points to the existence of a 'pool' of radioactive material outside of authorized control and potentially available for malicious use. Not all material in this 'pool' is suitable for malicious use. Some such as ^{192}Ir have relatively short half-lives and can be discounted once they have aged sufficiently. But some incidents involve 'dangerous'; i.e. Category 1, 2 and 3 radioactive sources, and yet more incidents involve material which may not be classified as dangerous but nevertheless could have useful disruptive, economic or psychological applications. Unfortunately, and by definition, the numbers, types and categories of material in the 'pool' whose theft or loss has not been detected are not known.

Where nuclear and other radioactive material is recovered, there is a good potential to draw generic lessons about regulatory and control systems, and protection measures. However, the scope for identifying specific vulnerabilities at the source — the facility from which it was originally stolen or lost — depends upon our ability to identify that point of origin. Nuclear forensics offers the possibility of identifying the origins of interdicted nuclear material, such as the HEU seized in Georgia, and subsequently addressing any weaknesses. For radioactive sources, the point of origin is harder to establish if regulatory and control systems are weak. The IAEA catalogue of radioactive sources will be of some assistance here but much more work is needed to establish comprehensive and reliable national inventories and to track sales and purchases, exports and imports, before a reliable system for identifying the origin of an interdicted or recovered radioactive source can be achieved.

5. MOTIVES, INTENTIONS AND THREATS

The motives and intentions of those involved in incidents are not always known. This poses problems in deciding whether criminality and malicious intent are factors. Roughly 42% of all incidents reported to the ITDB show direct evidence of some form of criminality (including theft). In reality, many other cases may have involved criminality, such as losses of material, unauthorized movement and recoveries of abandoned material; but we do not have sufficient information to know.

Criminality, however, does not equate to malicious intent. Other motives, primarily profit, are common. Many incidents reported to the database involve middlemen seeking only financial gain from selling the material — to whom does not matter, perhaps another middleman. But this only means that the potential threat is moved down the line of sellers and buyers. It does not mean that it disappears. Eventually, profit may turn into malicious use as the motive. Unfortunately, in the majority of cases, the next buyer or end user is unknown or unidentified.

Some incidents reported to the ITDB have involved suspected or real malicious intent. For example, in Germany in 2004, a suspected member of a terrorist organization reportedly showed interest in acquiring nuclear material and in Belgium in 2005, small quantities of UF_4 powder were mailed to various government and international officials in Brussels. More recently, a medical source was stolen while in transit with the apparent intention of using it in an RDD. Other past incidents reported in open sources occurred in Moscow, Russian Federation and Argun, Chechen Republic and involved radioactive sources. Neither has been confirmed to the ITDB. Such incidents provide collateral for the substantial body of information which apparently exists on the interest of terrorist groups in nuclear terrorism.

There is also some evidence of the involvement of organized groups in illicit trafficking and other unauthorized activities. In its commonest and simplest form, this involves a conspiracy apparently established for a single criminal enterprise. A second form of organization which has been seen is a criminal group which involves repeat offenders; one hesitates to call them specialists but there are indications that they have trafficked or attempted to traffic material more than once. Lastly, there are well established organized crime groups which are involved in multifaceted criminal activities. There is very little evidence of their involvement in nuclear trafficking and other unauthorized activities; just some allegations of possible mafia involvement in an incident of trafficking of LEU and, according to open source reports, of involvement in illegal disposal of radioactive waste.

Most reported cases of seizures of material/interdiction of trafficking activities involve amateurish and technically naive sellers who usually do not have a specific buyer. Both sets of characteristics make them vulnerable to counter trafficking activities by national security forces both through their incompetence and the need to ‘advertise’ their wares to find a buyer. We must be concerned that more experienced and professional criminals, such as organized crime groups or terrorist groups, will be much harder to interdict.

6. THE MARKET

Incidents reported to the ITDB show a consistent perception among sellers that there is a black market for nuclear and other radioactive material. Although a lot of sellers have little understanding of what they are trying to sell, others are not so technically ignorant. They will try to pass off benign material as something more sinister but at the same time they may actively seek to acquire real nuclear and other radioactive material to offer for sale. Aside from scams, the perception of a market encourages thefts of nuclear and other radioactive material from the authorized owners and, most worryingly, raises the possibility that material of high security concern will be stolen, sold on the black market and eventually acquired by terrorist groups. So there is only some comfort in concluding that sellers only perceive a black market to exist and that there is little evidence of a buyer driven market. Perceived markets could become real sources of supply.

7. CONCLUSIONS

In conclusion, belying illicit trafficking — both indicators and other activities involving unauthorized possession — are symptoms of malicious intent, perceived markets and the search for profit. They are also symptoms of vulnerabilities in legislative, regulatory and accounting systems, either in their scope or implementation; they are symptoms of vulnerabilities and weaknesses in physical protection and other preventive security systems, either facility specific or generic; and they are symptomatic of vulnerabilities in detection and interdiction systems. To address the trafficking problem and, thereby, reduce or eliminate the related threat, we must address the causes. Just like medicine, prevention is better than cure and potentially less expensive. For nuclear security, this means a comprehensive approach to addressing the threat — an approach which encompasses preventing acquisition of material suitable for malicious use; timely detection of losses and thefts; and effective detection and interdiction measures to prevent movement of material.

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ILLICIT TRAFFICKING — THE NATURE OF THE TRADE*

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The scope of the paper is on the nature of trade in illicit nuclear and radiological material. The paper draws on open source and IAEA data. It is an unclassified paper that draws on the above sources and does not represent the full extent of the United Kingdom's analysis on the subject. The discussion focuses on the intent that international terrorist groups have to acquire nuclear and radiological materials, and to deploy them in the form of radiological dispersal devices or improvised nuclear devices. The paper explores to what extent this intent drives and shapes the market for these materials. It uses IAEA data and current open source material to illustrate the availability and potential reservoir of sources that are available to traffickers and, from them — potentially — to terrorist groups. It combines this data with information from seizures to illustrate the supply side factors which shape the market. In relation to trafficking, the paper explores what we currently can assess from the IAEA and open source data, and makes judgements on the nature of the trade, and how individual nations should use this to inform the level and type of detection capability that they deploy. The paper also explores what further information or data sets would assist the analysis and interpretation of this trade.

* The full paper was not available for publication. The synopsis appears in its place.

IAEA-CN-154/077

RADIOLOGICAL AND NUCLEAR TRAFFICKING THREATS AND INTERPOL PROGRAMMES*

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INTERPOL's Project Geiger is an analytical project sponsored by the US Department of Energy and in partnership with the IAEA. Project Geiger has developed and populated a database of illicit trafficking incidents. With these data as well as with other official and open source reports, INTERPOL conducts trend, pattern and threat analysis for law enforcement organizations and INTERPOL's member countries. In addition, INTERPOL's other police services are available to its Member States to prevent, prepare for and respond to any radiological or nuclear incidents or crimes. INTERPOL facilitates police cooperation and coordination, and can provide direct support to its member States with major event or incident response teams.

* The full paper was not available for publication. The synopsis appears in its place.

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WORLD CUSTOMS ORGANIZATION SAFE FRAMEWORK OF STANDARDS

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Abstract

Customs administrations worldwide face the trade security/trade facilitation dilemma. On the one hand, there is continuing growth in legitimate international trade, while on the other, there is illicit cross-border movement of weapons of mass destruction, drugs, counterfeit merchandise, dual-use chemicals, small arms, nuclear material, undeclared merchandise, currency, cultural property, hazardous waste and people. In light of the terrorist threat to the global economy, nations seek economic and physical security from their customs administrations, while international traders look for uniformity, predictability, transparency and efficiency in their dealings with customs. The World Customs Organization (WCO) finds itself in the business of globalizing and, to the extent possible, standardizing customs control efforts to improve both the security and facilitation of the global supply chain. The most visible effort to this end is the SAFE framework, a global supply chain security initiative, developed at the WCO by the international trade community and WCO member customs administrations, to secure and facilitate the global supply chain.

Customs administrations worldwide face the trade security/trade facilitation dilemma. On the one hand, there is continuing growth in legitimate international trade, while on the other, there is illicit cross-border movement of weapons of mass destruction (WMD), drugs, counterfeit merchandise, dual-use chemicals, small arms, nuclear material, undeclared merchandise, currency, cultural property, hazardous waste and people.

In light of the terrorist threat to the global economy, nations seek economic and physical security from their customs administrations, while international traders look for uniformity, predictability, transparency and efficiency in their dealings with customs. The World Customs Organization (WCO) finds itself in the business of globalizing and, to the extent possible, standardizing customs control efforts to improve both the security and facilitation of the global supply chain. Our most visible effort to this end is the SAFE framework, a global supply chain security initiative, developed at the WCO by the international trade community and WCO member customs administrations, to secure and facilitate the global supply chain.

In the 15 to 20 years prior to the 11 September 2001 terrorist attacks, customs administrations, particularly in the developed world, began focusing more on trade facilitation rather than continuing to support unnecessary customs controls. At the WCO, this trade facilitation focus led to the negotiation of the revised Kyoto Convention on simplified customs procedures between 1995 and 1999. Today, 54 WCO members, including all of the world's major trading nations, are signatories to the revised Kyoto Convention. However, 11 September 2001 caused the world to refocus on customs control and recognize a simple truth, namely, that when faced with the global terrorist threat, every nation has the absolute right to determine who and what crosses its national borders. The instrument of this exercise of sovereign control is and always has been customs.

After the 11 September 2001 attacks, the stark recognition of the terrorist threat to the security of the international trade supply chain led the USA and others to seek the assistance of the WCO in securing the global supply chain that serves the world economy. The WCO responded and in 2002 established a joint customs/industry task force on security and facilitation of the global supply chain. Why a joint task with the private sector? While customs does interact with the global supply chain at import and possibly at export or in transit or in a free zone, the private sector controls and manages the global supply chain from end to end.

The joint customs/industry task force built on the work done by the WCO in drafting the revised Kyoto Convention and in short order produced recommendations and guidelines on:

— Integrated border management;
— A data model containing essential standard data elements/messages for the release of cargo;
— A unique consignment reference (UCR) policy.

Working together, customs and the private sector produced what is now called the SAFE framework. The SAFE framework was unanimously adopted by the WCO Council in June 2005. In June 2006, the WCO Council approved a document on authorized economic operators (AEOs) as part of the SAFE framework. This document contains the terms and conditions for the granting of AEO status to private sector entities that have secured their supply chain to the satisfaction of customs. This document also sets forth the customs clearance benefits a validated AEO will receive. To date, 149 of the 171 WCO members have signed a letter of intent to implement the SAFE framework. The theory underlying the SAFE framework is that appropriate, focused and layered trade security measures will actually facilitate the movement of legitimate trade across national borders and thereby protect the global economy.

The SAFE framework is the realization of the fact that security and facilitation are inextricably intertwined. However, our private sector partners have told us that every increase in trade chain security should be matched by an improvement in trade facilitation. To date, the anecdotal evidence shows that overall there has been an improvement in the facilitation of global trade despite the imposition of new customs security controls.

The SAFE framework has four core elements:

— Advance electronic manifest information;
— A consistent risk management approach;
— Use of non-intrusive detection equipment on high risk outbound export cargo prior to loading on a conveyance for exportation. The request will come from the nation importing the cargo;
— Enhanced trade facilitation for legitimate trade that meets certain security standards. In addition, AEOs can receive mutual recognition of their AEO status from other customs administrations for securing their entire supply chain.

The SAFE framework is built on two pillars:

— Customs to customs network arrangements;
— Customs to business partnerships.

While not specifically set forth in the SAFE framework, there is in reality a third pillar, namely, customs cooperation with other national, regional and international governmental organizations that have border control responsibilities. The WCO has engaged other regional and international governmental organizations, such as the United Nations, the World Trade Organization (WTO), the International Maritime Organization (IMO), the International Civil Aviation Organization (ICAO), the International Organization for Standardization (ISO), the International Labour Organization (ILO), the United Nations Economic Commission for Europe (UNECE), the Asia-Pacific Economic Cooperation (APEC), the European Union and the African Union (AU) to ensure that the SAFE framework is compatible with other security and facilitation guidelines being developed by those organizations and does not unduly burden the private sector with conflicting security standards. We also work closely with the United Nations Security Council Counter-Terrorism Committee (UNCTC), the IAEA, the United Nations Office on Drugs and Crime (UNODC), G8, the World Health Organization (WHO), the International Criminal Police Organization (INTERPOL), the Organisation for the Prohibition of Chemical Weapons (OPCW), the Organization for Security and Co-operation in Europe (OSCE) and other international organizations on security matters that can impact the global supply chain. We also work with all of these international organizations, the World Bank and regional development banks on training and capacity building.

The WCO has developed the integrated border management system to ensure open and secure borders. The integrated border management system provides for proper national and international cooperation and coordination of the various authorities involved in border management to ensure that borders are managed with maximum effectiveness and efficiency.

On a national level, customs administrations must work with their border partners in the national government to establish a 'single window' to receive advance cargo information electronically to ensure the rapid release of legitimate in bound cargo.

The SAFE framework is a comprehensive instrument that covers all areas of customs control, and provides a new and consolidated platform that will enhance world trade, ensure better security against terrorism and increase the contribution of customs and its global trade partners to the economic and social well being of nations.

The SAFE framework is a concept that moves the customs focus from import to export for security purposes. However, by focusing on the export of goods, customs will actually increase facilitation of legitimate cargo upon import. The concept is to identify high risk shipments early in the global supply chain, that is, at or before export, to allow for appropriate and timely control of high risk cargo prior to its introduction into the global supply chain's more significant transport systems. The SAFE framework foresees the more rapid release of legitimate cargo upon its import by identifying international traders that demonstrate an appropriate degree of security within their supply chain. This concept pushes security further back in the global supply chain by involving private sector AEOs who have increased security throughout their supply chain.

How are we doing in this balancing act between security and facilitation? Better than we were five years ago, but not yet where we want to be. Technology has been an enabler but infrastructure and customs staffing are still real issues we have to face. Inevitably, trade volumes have continued to grow and security needs have increased. It has long been apparent to customs that there are no physical security processes that can be successfully applied to match an ever expanding threat potential while, at the same time, facilitating the rapid clearance of legitimate trade across national borders.

Therefore, the sole means by which the safety of the global supply chain can be secured, without the imposition of a crippling impact on the necessary free flow of legitimate international trade, is through the consistent and effective application of well reasoned risk management regimes along with the effective use of technology and customs best practices in security and facilitation.

While security became the watch word after 11 September 2001, the WCO programme to control the export and import of nuclear and radiological materials was developed nearly 15 years ago to further customs efforts to protect the societies it serves. Ten years ago, working with the IAEA, the WCO developed recommendations covering customs actions against illicit cross-border movement of nuclear and hazardous materials. This comprehensive recommendation urged our members to recognize the need for the prevention, detection and repression of illicit movement of nuclear and hazardous substances, called for appropriate legislation and customs powers to deal with all aspects of illicit trafficking in nuclear and hazardous materials, called for cooperation, sharing of information on trafficking and urged efforts to detect illicit cross-border movement. The WCO has had a memorandum of understanding with the IAEA since 1998. We exchange information on illicit trafficking, co-sponsor seminars, and jointly develop technical and training materials with the IAEA.

The WCO collaborated with the IAEA in the production of technical documents on the prevention and detection of and the response to nuclear material in the global supply chain. The WCO participated in the development of an IAEA/customs radiation safety training course, reviewed the IAEA Illicit Trafficking Handbook [1] and the IAEA Guidelines for Monitoring Radioactive Material in International Mail [2].

The WCO developed and maintains the secure encrypted customs enforcement network, an Internet based information analysis and communication system for the fight against customs offences. It includes databases on nuclear materials and hazardous substances. The database includes technical information provided by companies on products with a customs control or detection application. This includes radiation detection equipment and container scanning equipment.

After the events of 11 September 2001, the WCO concentrated its efforts on security and facilitation of the international trade supply chain. The WCO Council adopted a 2002 resolution aimed at preventing the supply chain from being used for illegal purposes, such as smuggling weapons of mass destruction or their component parts.

The tools subsequently formulated, such as the use of advance electronic information, the application of risk assessment, customs to customs cooperation, customs to business partnerships, and the use of modern non-intrusive technology, were developed to provide enhanced security and, at the same time, to facilitate legitimate trade.

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ASSESSING THE PHENOMENON OF NUCLEAR TRAFFICKING

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Abstract

For over 15 years, the international community has focused considerable attention on the subject of illicit nuclear trafficking, yet the phenomenon of nuclear trafficking remains a subject where more is not known than is known. Our lack of understanding is all the more concerning since nuclear trafficking provides the pathway by which terrorist organizations could acquire nuclear and radiological materials for malicious purposes. The paper proposes a framework to produce actionable results that reduce risks and outlines a strategic approach to allow the international community to focus on illicit trafficking events that are of the greatest concern.

1. INTRODUCTION

On 29 October 2007, Reuters issued a news alert that authorities in Honduras detected radioactive materials in a shipping container filled with scrap metal. The container was on its way to Hong Kong [1]. Few details were provided about the material or the circumstances surrounding the event. Every analyst working on nuclear trafficking is familiar with similar reports on trafficking incidents from around the world — which often raise more questions than they answer. While this time the information came from Honduras, it could have been any other country, since this is quite a frequent occurrence.

For over 15 years, the international community has struggled with the issue of illicit nuclear trafficking and a significant amount of data have been accumulated; nonetheless, uncertainty remains on how concerned to be on this issue and how to go about combating it. The current framework of data collection and analysis typically does not provide enough information to produce actionable recommendations and thereby impedes our progress in combating nuclear trafficking. This paper outlines a path forward — including a set of actionable recommendations to expand our knowledge while reducing risks. Assessment should lead to the development of practical measures to reduce trafficking events. We propose the adoption of a utility credo for analysis of nuclear trafficking because the international community needs actionable information to prevent, detect and thwart nuclear and radiological events. Thus, in addition to measures to make it difficult for terrorists to acquire nuclear and radioactive materials, and make it easier to recognize and secure materials that have been lost or stolen, we need to ensure that efforts to combat trafficking are focused on nipping trafficking in the bud by combating its root causes.

2. LIMITATIONS OF THE CURRENT FRAMEWORK

The current framework limits our ability to develop effective practical recommendations to combat trafficking. Data collected over a dozen years has demonstrated that nuclear trafficking is a global phenomenon since incidents happen in all parts of the globe (Fig. 1) and the number of incidents seems to be increasing in spite of our efforts to curtail trafficking (Fig. 2). At the same time, the majority of reported cases do not have malicious intent. Overall, trafficking seems to be an irritating nuisance on an international scale.

We propose to expand our field of view on trafficking. By focusing on currently available data, we may be limiting our thinking; we need to augment our data gathering. In addition, we need to bring human factors into our analysis. Understanding the motivation and intent of those involved in nuclear trafficking is key to addressing the problem; by understanding the causes, we

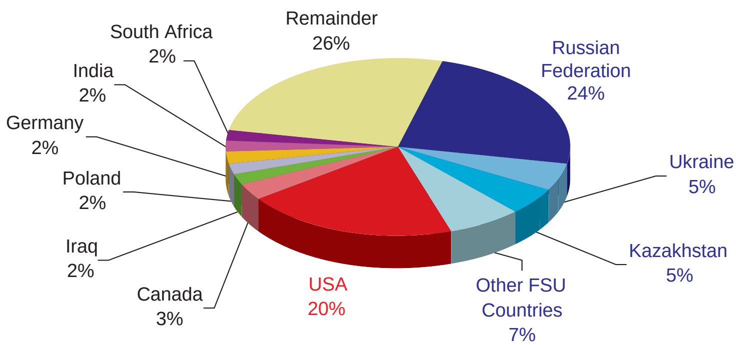

FIG. 1. Distribution of trafficking incidents by country worldwide.

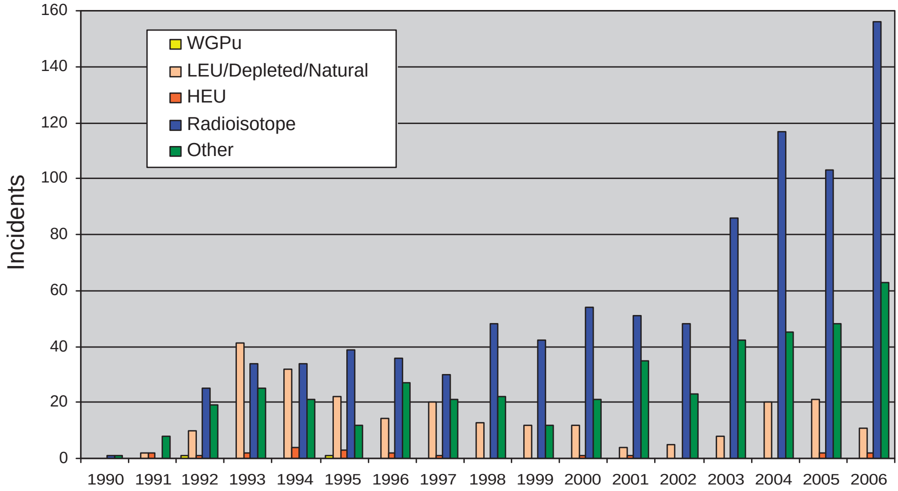

FIG. 2. Distribution of trafficking events by material category throughout the years.

will be better positioned to create incentives and countermeasures to combat trafficking.

3. EXPANDING THE FRAMEWORK

An expanded framework for assessing trafficking data should take into consideration issues such as motivation and intent. When we analyse trafficking events, we should also analyse trafficking behaviours. Therefore, in addition to the information on trafficked materials and the facilities they came from, we need information on perpetrators, their motivation and trafficking behavioural patterns. Also, since trafficking events do not occur in a vacuum, we need information on the environment in which the events took place. This includes specifics of the situation at the business and industry level, the regulatory climate, the level of law enforcement involvement and the society's attitudes and values. All this information is important so that we can determine the weaknesses which contribute to trafficking and address them. In other words, to properly analyse a trafficking event, we need to answer questions such as who, what, when, where, how, how much or how many and, most importantly, why. And very often this information is not available to us for analysis.

4. DATASETS

Datasets should be complete, factual and representative. The IAEA describes the scope of illicit trafficking data collection for its database as: “The unauthorized acquisition, provision, possession, use, transfer, or disposal of nuclear and other radioactive materials — whether intentional or unintentional and with or without crossing international borders.” [2]. Given this broad scope, information gathered includes many diverse events, for example, findings of disused and abandoned materials, scams, and illegal dumps of radioactive waste. However, without information on perpetrators and their motives, it may be difficult to make sense of reports on such a diverse set of events. Motives for trafficking events can serve as criteria to categorize trafficking events into groups for a later aggregate analysis.

Currently, we have other problems with the data collected, including under-reporting, non-reporting, and incomplete and contradictory information. By some estimates, only two out of three events are reported. Frequently, reported information does not give a complete picture. This may be because the authorities do not ask the right questions. Reports may not contain all collected information and databases may not record all the available information. Basically, at every step of the information gathering and reporting process, information loss and attrition of detail may occur. Since we rarely know why the trafficking incident occurs in the first place, little information is available about the reasons/motivations of the perpetrators and their intent regarding trafficked materials. As a result, root causes may not be known or established. We need descriptive information about trafficking events and observed behaviours of perpetrators which could provide information on their potential intent.

As an illustration of incomplete and contradictory information, consider this recent report on a thwarted smuggling attempt. The publication stated that border guards detained four people who tried to smuggle lovresium or ^{103}Lav to another country [3]. We would like to point out that while such material does not exist, there may well be some valuable information here that has been lost in the reporting process.

Perhaps the biggest issue we are facing is whether our trafficking datasets accurately represent reality. In data gathering, we heavily rely on reported information, whether it is reporting from the facility to its regulatory body, announcement of the police to the press or a country reporting to the IAEA. In essence, all of it is self-reporting. From statistical studies, we know that self-reported information contains self-sampling bias. This fact should be taken into account during trafficking information analysis.

Another related issue is that our datasets are not representative samples of the population since we know that we do not capture all events. For example, now we know that A.Q. Khan shipped nuclear materials to the Libyan Arab Jamahiriya, but we only know it post factum [4] by study of press reporting on the Khan network rather than as a reported trafficking event. This so-called silent evidence is not part of our datasets. We should be aware that not all events have been registered in our databases and, therefore, be very careful in interpreting our data and drawing practical recommendations based on them.

Thus, we can state:

— We do not have sufficient information to clearly understand the phenomenon of illicit nuclear trafficking — more is not known than is known;
— Our current use of frequency based analysis may be misleading and could encourage a false sense of security.

In our expanded framework, in order to reflect nuclear terrorist concerns, we propose considering two categories for the data: ‘noise’ and ‘signal’. Under ‘signal trafficking events’, we would consider all trafficking events associated with nuclear materials directly related to nuclear weapons, cases with nefarious intent and cases indicating nuclear black market activities. The remaining cases in our datasets we would consider as ‘noise trafficking events’.

However, we are not proposing discarding noise events for several reasons including:

— The sheer volume of noise of nuclear trafficking events may camouflage serious events:
  • An actual trafficking incident with nefarious intent may be lost in the noise of these cases.
— Noise nuclear trafficking events may be an indicator of an evolving nuclear black market:
  • The pathways built to operate a nuclear black market can be exploited;
  • The corruption and corrupt officials (that often go hand in hand with establishing a black market) can be exploited.
— Over time, the noise events breed complacency and diminish our awareness and therefore our response capabilities:
  • An event looking like a noise event can be easily overlooked resulting in bad consequences.

Based on our analysis, we believe that the most urgent task for now is to reduce the number of noise trafficking incidents, so that resources, time and effort are really devoted to the events of concern, such as trafficking with malevolent intent, trafficking in special nuclear materials whether by terrorists, opportunists or rogue States.

In addition, we need to do a better job of information gathering and obtaining all perspectives on the issue by reaching out to the industries involved, practitioners, end users, experts and analysts in other agencies — customs, law enforcement, intelligence — so we can fill the gaps in our knowledge.

Graphically, this strategy is shown in Fig. 3.

5. THE COMPOSITION OF NOISE EVENTS

Based on our data, noise events mostly comprise non-compliance trafficking, incidents with contaminated scrap metal, abandoned materials and various scams. The data collected indicate that most cases considered as noise in our classification are:

— Violations of rules and regulations, and non-compliance with transport or disposal regulations;
— Scrap metal;
— Legacy dumps, abandoned materials;
— Scams (offers, solicitations).

FIG. 3. Noise reduction strategy; the red bar is a signal event while blue depicts noise events. At the current level of high noise, the signal event is indiscernible at high noise background. Suppressing the noise reveals the signal.

Often, one single case can be a composition of the above, for example, contaminated scrap metal brought to a metallurgical plant for processing from an abandoned dump site.

We would like to use the following US case of regulatory non-compliance as an illustration of a noise case. In autumn 2007, R.U. Kubsh was charged with lying to the FBI and the US Department of Transportation. If convicted, he faces up to ten years in prison. In January 2007, Milwaukee police reported that a box with radioactive materials intended for a hospital was missing. Initially, Kubsh explained that the materials were stolen from his truck. Several days later, the box was found on the street by a passer-by. The investigation continued and it was determined that the box was lost while in transit. It was also determined that the box was found out with a regular route. Kubsh explained that while driving to the hospital he got lost and that the box fell off his truck and he could not find it afterwards [5].

This case underlines several issues: the prevalence of non-compliance trafficking cases in the USA, the current attitude toward compliance and a need for a thorough investigation. It was only due to persistent police investigation that it was determined that the initial story of material being stolen was not correct. It also demonstrates that a diligent effort is needed to get to the bottom of each case. Such diligent effort is required to acquire an understanding of the true causes of trafficking, whether noise or signal events.

This raises an important point which seems paradoxical. In order to get rid of noise, we need to study it better. Studying noise means:

— Considering all the information that we have about trafficking (illegal disposal, disused sources, etc.) and how it can be turned into anti-trafficking actions;
— Creating a system of incentives and punishments for facilities and individuals involved in non-compliance trafficking:
  - Address non-compliance trafficking;
  - Address legacy and old dumps;
  - Address disposal problem;
— As trafficking evolves, we need to stay up to date and monitor the situation continuously and constantly.

6. CHANGING ATTITUDE TOWARDS NUCLEAR TRAFFICKING

Reduction of noise trafficking incidents will not be possible without changing our attitude towards nuclear trafficking: among the public, practitioners and businesses. Another way to reduce trafficking is to foster awareness and intolerance among the general public and practitioners working with nuclear and radiological materials, combined with an appropriate legal framework. We need to strive to reach out to create intolerance towards any and all trafficking incidents. Without support from the public and business, efforts to combat nuclear trafficking will not succeed; practitioners should be on board and support intolerance towards trafficking. We need to drive home the notion that illicit nuclear trafficking is an undesirable societal behaviour and a crime.

An essential element of reducing trafficking is a complete set of legislation tools allowing authorities to perform a full investigation of all trafficking cases, including adjudication in a court of law. Some countries have inconsistent laws or not well developed procedures to prosecute trafficking crime and that inhibits our progress. We need to provide support and assistance to States that do not have resources to prosecute or bring the cases to the justice system.

Overall, since trafficking is such a broad issue crossing organizational boundaries within a country and, in many cases, crossing international borders, we need to grow or cultivate cross-border cooperation and regional partnerships, including:

— Greater cooperation on trafficking issues within a country:
  • Information sharing between regulatory authorities, police, legislation, industry, administration and political organizations within a country.
— Greater intercountry cooperation on trafficking issues:
  • Regional (transborder) cooperation;
  • Focus on geographic areas.

Successful prosecution of trafficking cases and just punishment can serve as a deterrent to potential traffickers. Here is an example from the USA of the successful investigation of non-compliance trafficking: the case of H.J. DeGregory, Jr. and his company H&G Import & Export (H&G), 2006. In August 2005, the company, based in Fort Lauderdale, Florida, was charged with illegally transporting ^{192}Ir sources from Florida to the Bahamas for the Bahamas Oil Refining Company (BORCO). The case revealed that it was not only that sources, transported while hidden in the wing, were undeclared, but that the company was not licensed to handle sources. The court decided and issued a verdict of forfeiture of two Piper aircrafts and two years in prison for the owner. The case also demonstrated how time consuming and costly it was to bring the case to the judge. It required intense cooperation among agencies ranging from the Federal Aviation Administration to Immigration and

Customs Enforcement. Do other countries have the resources to replicate this experience?

7. CONCLUSION

In conclusion, we would like to state that:

— The current framework of data collection and analysis typically does not provide enough information to produce actionable recommendations and thereby impedes our progress in combating nuclear trafficking. Our efforts should aim at producing actionable recommendations that reduce risks;

— To reflect our current nuclear security awareness, we propose to separate all trafficking data into two categories: noise and signal events. Moreover, in our view, the number of trafficking incidents is unacceptably high, producing noise that distracts our attention, takes our resources and camouflages the trafficking events of concern;

— Our first priority should be to reduce the noise domestically and internationally. This step should be taken with the understanding that we need to devote more effort to understanding the causes of noise trafficking in order to eliminate it;

— In addition, we also need to take into account that we do not have complete and full information, which is important for practical recommendations on how to reduce trafficking:
  - The information on motivation and intent should be better recorded;
  - If possible, the information about trafficking should be cross-checked with information from other agencies and other information which, while not directly linked to trafficking, can provide insights into trafficking, for example, estimates from practitioners in a field on how many incidents they have observed.

We must keep clearly in mind the objective of preventing nuclear terrorism by keeping nuclear and radioactive materials out of the hands of terrorists. As a final note, we also would like to emphasize the importance of noise reduction by using the haystack analogy. As illustrated in Fig. 4, it is easier to find a needle in a small stack than in a large one; and to accomplish this goal we all need to work together.

FIG. 4. A needle in a big haystack versus a needle in a small haystack.

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DISCUSSION

SESSION 1: Illicit Trafficking and Nuclear Terrorism — I

M. KHURSHID KHAN (Pakistan): I represent the Strategic Plans Division (SPD) of Pakistan, which is responsible for the safety and security of Pakistan's nuclear weapons and nuclear activities. I would like to clarify certain issues mentioned by the last speaker. The current political crisis in Pakistan has nothing to do with the safety and security of our nuclear weapons. Immediately after its nuclear test explosion in May 1998, Pakistan took steps to ensure that its nuclear activities and nuclear arsenal were in safe hands. As a responsible nuclear weapons State, Pakistan has established a National Command Authority (NCA), which is the body that takes policy decisions on nuclear related issues. The NCA has a politico–military structure with the President as Head, the Prime Minister as Vice-Chairman and the Ministers of Finance, Defence–Foreign Affairs and the Interior as members. The SPD functions as the NCA's secretariat, which has over 8000 well trained people to take care of the safety and security of Pakistan's nuclear activities. Pakistan's political leaders are neither extremist nor fundamentalist. Certainly, international terrorism is of great concern. Al Qaeda is scattered all over the world; it is not part of Pakistan but the concern of the international community. We are all striving hard to address the problem. Thus, the perception that Pakistan's nuclear weapons security is at risk needs to be corrected. As far as the A.Q. Khan network is concerned, people from over 20 countries are involved. We all need to address the issue of nuclear technology proliferation collectively. No individual country can be blamed in isolation. Once again, I assure you that Pakistan's nuclear activities are in safe hands and there is nothing to worry about.

A.J. AL KHATIBEH (Qatar): Two speakers mentioned 'Islamic attacks' and 'Islamic terrorists'. We do not think that these phrases are accurate. Terrorists do not represent Islam, nor do they have the approval of 1.5 billion Muslims. Those terrorists use Islam only as a cover. We condemn them.

P. GRIDLING (Europol): Europol does not speak about 'Islamic terrorism'. The term used by Europol is either 'religiously motivated terrorism' accompanied 'by Islamists' or 'Islamist extremism/terrorism'. This wording is in line with the European Union media strategy.

B. STICKNEY (United States of America): Regarding opium production in Afghanistan, do we have estimations on how much money is generated and how much of it flows to terrorist organizations such as Al Qaeda or the Taliban? Do we know what the mechanisms are?

I. CHATZIS (UNODC): The link between terrorism and organized crime is extremely difficult to quantify. It is an undisputed fact, though, that terrorists need money to buy weapons and explosives, and to finance their operations. Their activities often include major involvement in actual drug production and trafficking. Some are even known to 'tax' drug producers and traffickers. The UNODC 2007 World Drug Report has a lot of information regarding levels of drug production and profits from these illicit markets from Afghanistan and elsewhere.

M. COJBASIC (Serbia): Is there any official, routine cooperation between the UNODC and the IAEA in the nuclear field? If so, what kind of cooperation exists?

I. CHATZIS (UNODC): The UNODC does not collect data on illicit trafficking in nuclear material but we do cooperate regularly — though on an informal basis — with the IAEA on the exchange and analysis of information.

R. ARLT (Germany): A question to the panel and to the audience: In view of P. Gridling's statement that traffickers may circumvent fixed installed systems, has any country developed and used randomly deployed mobile detection systems in order to counteract this avoidance?

P. GRIDLING (Europol): Europol is not aware of such a case but avoidance of visible installations would be logical.

D. HUIZENGA (United States of America): The US Department of Energy Second Line of Defense is aware of this important problem and is working with law enforcement officials from several countries to develop detection systems to be used between fixed border locations. I shall be elaborating on this in my presentation.

S. ELEGBA (Nigeria): How do we reconcile the statistics given by E.R. Koch of 61% of people surveyed being afraid of an Islamist attack with the Europol data showing 498 cases in 11 Member States not involving any Islamist groups. Is it a case of public lack of awareness or that information is not made available?

P. GRIDLING (Europol): I presented statistics for 2006, which show that no successful attack related to Islamist extremism was detected in the European Union. There was only one case in Germany (the trolley bomb), which failed. Figures are published in Europol's TESAT 2007 report, available for download at www.europol.europa.eu. The limited presentation time here did not allow the elaboration of the results and the findings of the report.

S.J. STANLEY (United Kingdom): Has opium production in Afghanistan increased or decreased over the past five to ten years and what are the reasons for changes?

I. CHATZIS (UNODC): Opium production in Afghanistan has increased dramatically in the past few years. It was decreasing until approximately 2001 but has been steadily increasing since then. According to the UNODC 2007 World Drug Report, Afghanistan now produces 92% of the world's opium.

SESSION 1: Illicit Trafficking and Nuclear Terrorism — II

A. SEMMEL (United States of America): As the speakers have indicated, the fact that much more is not known than known can lull us into a false sense of security.

S. ELEGBA (Nigeria): The signal to noise ratio is very interesting. One has to make a distinction between noise coming from the regulatory body and that from the press. Media hype tends to promote the noise nationally and internationally. For example, an article in the London Sunday Times of 6 October 2002 implied that it was possible to acquire a dirty bomb by telephone, showing a map of Africa and Nigeria. The text described how the sting operation was foiled by the Nigerian Nuclear Regulatory Authority, which was branded, nevertheless, 'difficult' and 'bureaucratic'. This hype aimed to undermine security arrangements in Nigeria. It demonstrates that it is necessary to work closely and carefully with the press to separate hype from factual information.

G.I. BALATSKY (United States of America): The role of the press can be very important. It can ignite interest and create false expectations of large monetary gains from the sale of nuclear material, thus encouraging opportunistic crime. On the other hand, the press can help increase public awareness and concern about illicit trafficking so we need to work together.

A.J. AL KHATIBEH (Qatar): Are the various international organizations (e.g. World Customs Organization, INTERPOL, Europol) exchanging information on illicit trafficking of nuclear material effectively and disseminating it to the concerned countries?

R.A.G. HOSKINS (IAEA): Yes, to the extent they are legally permitted. The IAEA makes data from the Illicit Trafficking Database (ITDB) available to a number of international organizations — including those you mentioned — and to IAEA Member States. In addition, Project Geiger is a major cooperation/exchange activity between the IAEA and INTERPOL.

E.K. SOKOVA (United States of America): What accounts for the difference in the number of cases registered by the IAEA and by INTERPOL (1200 versus 1400)?

R.A.G. HOSKINS (IAEA): The IAEA figure includes only ITDB data covering incidents reported officially to the IAEA by States. We keep the open source information separate and use it to prime questions to the concerned States to validate information. The INTERPOL figure includes both ITDB data and reports from open sources and other resources, so it is a larger data set.

J. MASON-PONTING (INTERPOL): We also record data from 186 member countries as opposed to the 99 reporting to the ITDB, so some countries report to us that are not necessarily going to report to the IAEA.

A. SEMMEL (United States of America): There are also other databases around, such as NTI, so the question can be magnified to the multiplicity of databases.

S.J. STANLEY (United Kingdom): How successful is shielding in reducing the detectability of illicit radioactive material?

I. GILL (United Kingdom): Not very. The traffickers believe that shielding will prevent detection, but this partly relies on the material being smuggled. Perhaps HEU could escape detection through shielding but a highly active source such as caesium or cobalt would need so much lead shielding that you would not be able to move it.

M. CAMPBELL (United Kingdom): While appreciating that data are being shared and analysed, I am concerned about dissemination of the product of that analysis. Criminal intelligence in one definition is information designed for action. How can we ensure that the information is passed on to the national level agency best able to use it? For example, intelligence identifying a suspect company might be recorded in a customs database but may be more appropriate for police than for customs. Are we sure that tactical intelligence is reaching the right agencies?

J. MASON-PONTING (INTERPOL): In each of our 186 countries, INTERPOL has a national central bureau (NCB) that is our formal point of contact. A stumbling point could be at the national level — whether they then pass on information to the correct individuals. Therefore, we try to build up national contact networks — identifying contact points also for specialized units — and get the NCB to authorize our having direct contact with them.

INTERNATIONAL INSTRUMENTS AND THEIR IMPLEMENTATION

(Session 2)

Chairperson

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Malaysia

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IAEA-CN-154/008

MODEL ELEMENTS FOR A NATIONAL LEGAL FRAMEWORK ON ILLICIT TRAFFICKING

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Abstract

A number of new and revised international instruments and guidance documents either require or recommend basic elements for a national legal framework to restrain illicit trafficking in nuclear and other radioactive materials. Nations that have adhered to these instruments or that are considering adherence may need to adopt new or revise existing national laws to make them consistent with international legal requirements and best practice. Given the number and scope of these different instruments, legislative drafters may find it challenging to identify the key elements that need to be included in national legislation. Another challenge is to draft legislation in a manner that concisely, accurately and consistently codifies the somewhat differently framed provisions in several instruments. Also, recognizing that legislative drafting practices vary considerably among different nations, a further issue is how to adjust these elements in a way that complies with the national approach, while achieving the maximum degree of harmonization with international norms and practices. The objective of the paper is to identify a concise set of legislative elements that should be included in national legislation addressing illicit trafficking and nuclear export and import control. Ten model provisions on illicit trafficking and eight provisions on nuclear export and import control have been derived from the various relevant international instruments and documents. These provisions represent a basic, minimum set of articles that could be included in national legislation to establish a legal framework for addressing the threat of illicit trafficking. For each model provision, references indicate the instruments from which the provision was derived, including the applicable section, article or paragraph. Nations may, of course, go beyond this minimum set of provisions to address additional subjects or provide greater detail in their legislation, depending on national policies and practices. The paper should be of greatest utility for nations having little or no legislation in this area. However, even for nations with well developed legal frameworks, the paper may provide a useful template for reviewing their laws to identify gaps and inconsistencies or outdated provisions needing revision.

1. INTRODUCTION

Nuclear related illicit trafficking has been defined as "…incidents which involve unauthorized acquisition, provision, possession, use, transfer or disposal of nuclear materials, whether intentional or unintentional and with or without crossing international borders, including unsuccessful and thwarted events" [1]. Some recent commentators have suggested that making such trafficking (sometimes called nuclear smuggling) a crime against humanity, prosecutable in an international criminal tribunal would make an important contribution to constraining such activities [2]. However, in the near term, it is unlikely that an initiative to make nuclear related illicit trafficking an international crime will move forward expeditiously.[1]

Preventing and responding to incidents of illicit trafficking has traditionally been regarded as primarily a matter within the sovereign authority of national governments. Measures to address security threats, including illicit trafficking, obviously involve sensitive matters, including the exercise of police powers, intelligence matters, assessing the reliability of persons working with nuclear materials, and criminal investigation and prosecution. Understandably, governments have been reluctant to subject these matters to international oversight. A limited exception has been the area of physical protection, with promulgation of the INFCIRC/225 recommendations by the IAEA in 1972 (subsequently revised in 1977, 1989 and 1993), and adoption of the Convention on the Physical Protection of Nuclear Material in 1979 (entered into force in 1987). Both of these instruments focus primarily on protection of nuclear material in international commerce. However, as a result of recent terrorist incidents, the IAEA and its Member States, as well as other relevant international bodies, have given increasing attention to international approaches that could contribute to preventing the acquisition of nuclear and other radioactive materials by groups that might seek to use them for malicious purposes. The international community has come to recognize that the threat of illicit trafficking possesses an international dimension which requires an international response. Part of that response is reflected in a growing number of international instruments and guidance documents addressing this threat. The most important of these instruments and documents are summarized in Section 2 of this paper. They can encourage a valuable measure of harmonization and cooperation in efforts to restrain illicit trafficking. However, as will be seen, the

[1] A useful discussion of the difficulties of internationalizing a crime of illicit trafficking is contained in Ref. [3].

basic international legal framework continues to place primary responsibility for combating illicit trafficking with national governments.

Nations that have adhered to these instruments or that are considering adherence may need to consider adopting or revising national laws to make them consistent with international legal requirements or best practice. Some of these new or revised international instruments or guidance documents require governments to adopt new or expanded criminal or penal legislation to deal with nuclear related security issues. This suggests a need to ensure a synergy between a State's criminal and penal legislation, and its nuclear laws. Harmonization of national laws and related procedures in these areas can also help avoid or resolve difficult issues, such as dual criminality and extradition of alleged offenders.

Given the number and scope of these different instruments, legislative drafters may find it challenging to identify the key elements that need to be included in national legislation. Another challenge is to draft legislation in a manner that concisely, accurately and consistently codifies the somewhat differently framed provisions in several instruments. Also, recognizing that legislative drafting practices vary considerably among different nations, a further issue is how to adjust these elements in a way that complies with the national approach, while achieving the maximum degree of harmonization with international norms and practices.

Another issue of significance for illicit trafficking is extending the scope of coverage of relevant controls to cover radioactive materials that are not relevant for nuclear explosives, but could be used to produce a so-called radiological dispersal device (RDD) or 'dirty bomb'. The majority of international instruments in the nuclear security field limit their scope to nuclear material or nuclear weapons. RDDs are not considered a nuclear weapon, nor are they typically considered as a weapon of mass destruction (another term used in some instruments). However, the recent Nuclear Terrorism Convention includes 'radioactive material' of the kind suitable for RDDs within the category of materials subject to its provisions (e.g. materials or substances "…which may, owing to their radiological or fissile properties, cause death, serious bodily injury or substantial damage to property or to the environment"). Also, certain categories of radioactive sources may contain types or quantities of radioactive material that could be used in an RDD. The IAEA Code of Conduct on the Safety and Security of Radioactive Sources provides that States should establish a legislative and regulatory framework which includes requirements for security measures to deter, detect and delay the unauthorized access to, or the theft, loss or unauthorized use or removal of radioactive sources during all stages of management and the capacity to take appropriate enforcement actions.

2. INTERNATIONAL INSTRUMENTS AND GUIDANCE DOCUMENTS RELEVANT FOR ILLICIT TRAFFICKING

The most relevant international instruments for illicit trafficking discussed in this section include:

- The Convention on the Physical Protection of Nuclear Material (CPPNM);
- The Amendment to the Convention on the Physical Protection of Nuclear Material of 2005;
- United Nations Security Council Resolution 1373 on terrorist financing (2001);
- United Nations Security Council Resolution 1540 on weapons of mass destruction (2004);
- International Convention for the Suppression of Acts of Nuclear Terrorism (NTC) opened for signature in 2005, entered into force on 7 July 2007;
- The Treaty on the Non-Proliferation of Nuclear Weapons (NPT);
- IAEA Safeguards Agreements and Additional Protocol;
- Regional Nuclear Weapon-Free Zone Treaties:
  - Tlatelolco Treaty (for Latin America);
  - Rarotonga Treaty (for the South Pacific);
  - Bangkok Treaty (for South East Asia);
  - Pelindaba Treaty (for Africa);
  - Central Asia Treaty.

In addition, a range of non-binding instruments or IAEA Guidance Documents may be relevant. They include:

- Code of Conduct on the Safety and Security of Radioactive Sources (2004);
- Guidance on the Import and Export of Radioactive Sources (2005);
- Nuclear Suppliers' Group (NSG) Guidelines;
- Zangger Committee Guidelines;
- IAEA Security Series.

This section contains a summary discussion of these instruments and guidance documents to provide a basis for identifying key elements for a national legal and regulatory framework to combat nuclear related illicit trafficking.

2.1. Convention on the Physical Protection of Nuclear Material

The earliest international instrument related to nuclear security is the Convention on the Physical Protection of Nuclear Material (CPPNM). (The Convention on the Physical Protection of Nuclear Material, IAEA Document INFCIRC/274/Rev. 1, IAEA, Vienna (1980) entered into force in 1987.) The CPPNM currently has 128 parties, including most States with significant nuclear activities. The CPPNM was primarily focused on protection of nuclear material in international transit. However, it also contains other measures related to domestic physical protection. For purposes of illicit trafficking, the most important provision of the Convention is Article 7 that requires parties to make a range of intentional actions punishable as offences under their national laws. Specifically, the provision criminalizes "[a]n act without lawful authority which constitutes the receipt, possession, use, transfer, alteration, disposal or dispersal of nuclear material and which causes or is likely to cause death or serious injury to any person or substantial damage to property" (Article 7.1.a). Also criminalized are thefts, threats to use nuclear material or to compel action, attempts and participation in unlawful acts proscribed by the Convention. Other articles require State parties to establish jurisdiction over Article 7 offences (Article 8), detention of alleged offenders for purposes of prosecution or extradition (Article 9), prosecution or extradition (Article 10) and defining Article 7 offences as extraditable offences in extradition treaties (Article 11). Article 13 requires that parties afford each other "the greatest measure of assistance" in criminal proceedings.

2.2. Amendment to the Convention on Physical Protection

The 2005 Amendment to the CPPNM[2] would significantly extend the scope of the earlier instrument to cover domestic nuclear activities and sabotage of nuclear facilities or material in use, storage or transport. The Amendment requires State parties to establish, implement and maintain an appropriate physical protection regime with the aim of protecting against theft or other unlawful taking of covered materials; ensuring implementation of rapid measures to recover missing or stolen material; protecting facilities and material from sabotage; and mitigating or minimizing radiological consequences of sabotage. To implement this regime, State parties shall establish and

[2] The CPPNM Amendment was adopted and circulated to all parties in July 2005 as IAEA document GC(49)/INF/6. Two thirds of the parties must deposit an instrument of acceptance of the amendment before its entry into force.

maintain a legislative and legal framework for physical protection; designate a competent authority responsible for implementing this framework; and take other appropriate measures for physical protection. Another significant feature of the Amendment is the identification of 12 fundamental principles of physical protection that should be applied by State parties “insofar as is reasonable and practicable”. These principles cover the following subjects: responsibility of the State; responsibilities during international transport; legislative and regulatory framework; competent authority; responsibility of licence holders; security culture; threat; graded approach; defence in depth; quality assurance; contingency plans; and confidentiality. Other provisions of the Amendment require State parties to identify and make known to each other and the IAEA a point of contact for matters within the scope of the Convention and to strengthen measures of information sharing, coordination and cooperation in dealing with cases of sabotage, theft or unauthorized acquisition of nuclear material. Other provisions of the Amendment extend the list of acts regarding nuclear materials that must be made punishable offences under national law. It is notable that smuggling of nuclear material has been added to this list. The Amendment also clarifies matters regarding extradition of persons suspected of committing such offences.

2.3. United Nations Security Council Resolution 1373

United Nations Security Council Resolution 1373 was adopted on 28 September 2001 in the wake of the 11 September 2001 terrorist attacks in the USA. The resolution seeks to increase international cooperation and enhance national measures “to prevent and suppress […] the financing and preparation of any acts of terrorism”. By affirming that “any act of international terrorism constitute[s] a threat to international peace and security” the Council makes its provisions mandatory for all Member States under Chapter VII of the United Nations Charter. Some twenty measures to be taken by Member States can be derived from the resolution. Eleven of these are required under decisions of the Council. Nine others are measures the Member States are called upon to take on a voluntary basis. Only one of the provisions specifically mentions nuclear materials, although another uses the term ‘weapons of mass destruction’ that must be taken to include nuclear weapons, although not RDDs or ‘dirty bombs’. Operative Paragraph 4 specifically addresses illicit trafficking, with the Council noting:

> “…with concern the close connection between international terrorism and transnational organized crime […] and illegal movement of nuclear […] and other potentially deadly materials,

> and in this regard emphasizes the need to enhance coordination efforts on national, subregional, regional and international levels in order to strengthen a global response to this serious challenge and threat to international security."

2.4. United Nations Security Council Resolution 1540

In April 2004, the United Nations Security Council adopted Resolution 1540 concerning weapons of mass destruction. The resolution was adopted pursuant to the Council's authority under Chapter VII of the United Nations Charter to address threats to international peace and security. Thus, its provisions are mandatory for all United Nations Member States. The Council decided that:

> "all States shall take and enforce effective measures to establish domestic controls to prevent the proliferation of nuclear, chemical, or biological weapons and their means of delivery, including by establishing appropriate controls over related materials and to this end shall:

- Develop and maintain appropriate effective measures to account for and secure such items in production, use, storage or transport;
- Develop and maintain appropriate effective physical protection measures;
- Develop and maintain appropriate effective border controls and law enforcement efforts to detect, deter, prevent and combat, including through international cooperation when necessary, the illicit trafficking and brokering in such items in accordance with their national legal authorities and legislation and consistent with international law;
- Establish, develop, review and maintain appropriate effective national export and trans-shipment controls over such items, including appropriate laws and regulations to control export, transit, trans-shipment and re-export and controls on providing funds and services related to such export and trans-shipment such as establishing end-user controls; and establishing and enforcing appropriate criminal or civil penalties for violations of such export control laws and regulations."

2.5. International Convention for the Suppression of Acts of Nuclear Terrorism

The most recent multilateral instrument in the nuclear security field to enter into force is the International Convention for the Suppression of Acts of Nuclear Terrorism. Opened for signature in September 2005, the Convention entered into force in July 2007. The preamble of the Convention expresses concern about the worldwide escalation of acts of terrorism and identifies an "urgent need to enhance international cooperation between States in devising and adopting effective and practical measures for the prevention" of acts of nuclear terrorism. Article 1 of the Convention makes its broad scope clear by defining four key terms. The definitions of 'radioactive material', 'nuclear material', 'nuclear facility' and 'device' are incorporated into Article 2, which codifies a range of offences intended to cause death or serious bodily injury or substantial damage to property or the environment. These offences include terrorist acts associated with the development of nuclear explosives, RDDs (so-called dirty bombs) and damage to nuclear facilities. Additional offences are created for threats, demands, attempts, participation as an accomplice organization or direction and contribution to acts of nuclear terrorism. Article 5 requires State parties to establish the offences set forth in Article 2 as criminal offences under national law. Additional articles in the Convention establish a range of other obligations, including measures to counter nuclear terrorism; exchange information; detect, prevent and respond to nuclear terrorist acts; identify competent authorities and identify liaison points. A number of other articles deal with jurisdictional and procedural issues arising from the apprehension and prosecution of persons alleged to have committed offences identified in the Convention. A duty to "prosecute or extradite" (known in international law as the doctrine of 'aut dedere, aut judicare') is codified in Article 13 [4]. Very important obligations to render harmless and ensure the protection of any radioactive material seized during incidents of possible nuclear terrorism are set forth in Article 18. This article also incorporates by reference the IAEA's safeguards measures and physical protection recommendations.

2.6. Treaty on the Non-Proliferation of Nuclear Weapons (NPT)

As indicated by its title, the NPT addresses the spread of nuclear weapons to additional States. However, its Article III requirement that transfers of nuclear materials and especially designed or prepared items be conditioned on the application of IAEA safeguards has long played a role in ensuring oversight over exports and imports that could pose nuclear security dangers. The so-called 'trigger list' developed by the NPT exporters (Zangger

Committee) was the first multilateral nuclear list of commodities that needed monitoring to ensure their peaceful uses.

2.7. IAEA Safeguards Agreements and Additional Protocol

Provisions relevant for national export and import legislation are contained in Safeguards Agreements concluded between a State and the IAEA based on relevant safeguards documents. Comprehensive Safeguards Agreements (CSAs) under the NPT contain provisions related to international transfers of nuclear material (see Paragraphs 34 and 91–97 of INFCIRC/153). Broadened information requirements on nuclear related exports and imports are set forth in the Model Additional Protocol (See INFCIRC/540). In particular, reporting requirements have been added by Article 2.a.(ix) for specified equipment and non-nuclear material set forth in Annex II. Annex II contains an extensive list of equipment and non-nuclear material related to the following:

— Reactors and equipment therefore;
— Non-nuclear materials for reactors (deuterium, heavy water and nuclear grade graphite);
— Plants for the reprocessing of irradiated fuel elements and equipment especially designed or prepared therefore;
— Plants for the fabrication of fuel elements;
— Plants for the separation of isotopes of uranium and equipment, other than analytical instruments, especially designed or prepared therefore;
— Plants for the production of heavy water, deuterium and deuterium compounds and equipment especially designed or prepared therefore;
— Plants for the conversion of uranium and equipment especially designed or prepared therefore.

2.8. Regional nuclear weapon-free zone treaties

Five regional instruments have been developed over the past four decades for the purpose of excluding nuclear weapons from defined areas of the world. Although focused on the proliferation of nuclear weapons to additional States, some of their provisions are applicable to the prevention of illicit trafficking of nuclear materials and related items or technology. These provisions, which may be relevant for legislative development in States in the respective regions, can be briefly noted.

The Tlatelolco Treaty for Latin America [5] contains a very broad provision in Article 1.1(b) which commits the parties to “prohibit or prevent in their territories … the receipt, storage, installation, deployment and any form of possession of any nuclear weapon, directly or indirectly, by the Parties themselves, by anyone on their behalf or in any other way." The language is clearly broad enough to encompass illicit trafficking of materials intended for nuclear weapons development.

The Rarotonga Treaty for the South Pacific [6] contains Article 3 committing the parties "not to take any action to assist or encourage the manufacture or acquisition of any nuclear explosive device by any State." This provision would arguably not specifically cover subnational illicit trafficking. However, implementation measures would certainly provide some protection against that threat.

The Bangkok Treaty for South East Asia [7] contains Article 4.3 of the treaty requiring the parties "not to provide source or fissionable material or material especially designed or prepared for the processing, use or production of special fissionable material to any non-nuclear weapons State" in the absence of IAEA safeguards. Although the provision applies to States, implementing actions would protect against subnational traffickers.

The Pelindaba Treaty for Africa [8] has not yet entered into force. Article 3(c) of the treaty states that "[e]ach party undertakes not to take any action to assist or encourage the research on, development, manufacture, stockpiling, or acquisition or possession of any nuclear explosive device." This provision does not seem limited to State action and should be interpreted to cover subnational trafficking.

The Central Asia Treaty [9] has also not yet entered into force. Article 3.1(c) is identical to Article 3(c) of the Pelindaba Treaty. Further, Article 3.1(d)(iii) states that a party shall "not allow in its territory […] any actions, by anyone, to assist or encourage the development, production, stockpiling, acquisition, possession of or control over any nuclear weapon or other nuclear explosive device." The provision clearly seems aimed at the subnational threat, including illicit trafficking.

2.9. Code of Conduct on the Safety and Security of Radioactive Sources

The 2004 Code of Conduct on the Safety and Security of Radioactive Sources provides detailed guidance on measures needed to protect individuals, society and the environment from the harmful effects of possible accidents and malicious acts involving radioactive sources. In brief, the Code is structured into three basic parts, with an important Annex I that divides the most commonly used radiation sources into three categories based on the likelihood that they would cause severe or permanent injury if not safely managed or securely protected. Part I of the Code provides definitions of key terms, an important aid for harmonizing implementation among State parties and users of sources. Part II defines the scope and objectives of the Code, making clear that it does not apply to nuclear material (except for sources incorporating ^{239}Pu) or sources in military or defence activities. The very detailed Part III is the most important for developing a legislative and regulatory framework to cover sources. This part, entitled "Basic Principles" provides guidance in several areas, including general matters; legislation and regulations; regulatory body; import and export of radioactive sources; role of the IAEA; and dissemination of the Code.

2.10. Guidance on the Import and Export of Radioactive Sources

In an initiative related to the promulgation of the Code of Conduct on the Safety and Security of Radioactive Sources in 2004, the IAEA developed a document entitled Guidance on the Import and Export of Radioactive Sources that contains a number of provisions that States should consider adopting to prevent the diversion of sources that could jeopardize safety and security. The Guidance follows the categorization of sources adopted in the Code of Conduct and provides a useful framework for review of applications and decisions on authorizing the export or import of radioactive sources in Categories I and II. The basic elements of the Guidance are as follows:

— Identification of a point of contact by each State for facilitating export and import of relevant sources;
— For export authorizations, a set of procedures that includes recommended factors to be considered in granting consent to export, information to be provided in a request for consent, criteria for evaluation of a request, and notification prior to shipment;
— For import authorizations, a number of factors to be considered;
— Guidance on handling of cases involving exceptional circumstances, such as considerable health or medical need or imminent radiological hazard;
— Factors relating to transit and trans-shipment;
— If a State Self-Assessment Questionnaire (in Annex I) is set forth in other parts of the law, it need not be included in a separate chapter on export and import controls.

2.11. IAEA Safeguards Agreements

Provisions relevant for national export and import legislation are contained in Safeguards Agreements concluded between a State and the IAEA based on relevant safeguards documents. CSAs under the NPT contain provisions related to international transfers of nuclear material (see Paragraphs 34 and 91–97 of INFCIRC/153). Broadened information requirements on nuclear related exports and imports are set forth in the Model Additional Protocol (see INFCIRC/540). In particular, reporting requirements have been added by Article 2.a.(ix) for specified equipment and non-nuclear material set forth in Annex II. Annex II contains an extensive list of equipment and non-nuclear material related to the following:

- Reactors and equipment therefore;
- Non-nuclear materials for reactors (deuterium, heavy water and nuclear grade graphite);
- Plants for the reprocessing of irradiated fuel elements and equipment especially designed or prepared therefore;
- Plants for the fabrication of fuel elements;
- Plants for the separation of isotopes of uranium and equipment, other than analytical instruments, especially designed or prepared therefore;
- Plants for the production of heavy water, deuterium and deuterium compounds and equipment especially designed or prepared therefore;
- Plants for the conversion of uranium and equipment especially designed or prepared therefore.

2.12. Nuclear suppliers' group guidelines[3]

Since the mid-1970s, a number of States have committed themselves to controlling the export of certain material, items and technology in accordance with procedures agreed by a group of States (see Guidelines for Nuclear Transfers — Communication received from certain Member States regarding Guidelines for the Export of Nuclear Material Equipment and Technology, IAEA INFCIRC/254/Rev. 8/Part 1 — 20 March 2006 and Communications received from Certain Member States regarding Guidelines for Transfers of Nuclear-related Dual-use Equipment, Materials, Software and related Technology, IAEA INFCIRC/254/Rev. 6/Part 2 — February 2005). Although these guidelines are primarily focused on preventing the spread of nuclear weapons capabilities to additional States, they have great value in keeping dangerous materials and items out of the hands of would-be nuclear terrorist or criminal elements.

[3] A useful description of the two nuclear suppliers' groups (NSG and Zangger Committee) is set out in INFCIRC/539/Rev. 3, IAEA, Vienna, 30 May 2005.

2.13. Zangger Committee Guidelines

The original nuclear export control list developed by a group of NPT supplier States in 1971 was intended to implement the Treaty's requirement in Article III that certain materials and items especially designed or prepared (EDP) for processing, use or production of special fissionable materials would not be exported unless covered by IAEA safeguards. These treaty based controls continue to be applied under IAEA document INFCIRC/209, although NSG controls are much broader, including the requirement, since 1992, that non-nuclear weapon State recipients accept so-called 'full scope safeguards' over their entire nuclear fuel cycle.

2.14. IAEA Nuclear Security Series

As a result of recent decisions by the IAEA's Board of Governors and General Conference, the IAEA is implementing its Nuclear Security Plan for 2006–2009. That plan envisages the development of a range of security guidance documents to parallel the long standing IAEA Safety Standards Series. As of mid-2007, at least 14 documents in this Nuclear Security Series have either been published, approved for publication, or are in advanced stages of development. Those related to illicit trafficking that have already been published or approved for publication include:

- Technical and Functional Specifications for Border Monitoring Equipment (IAEA Nuclear Security Series No. 1);
- Nuclear Forensic Support (IAEA Nuclear Security Series No. 2);
- Combating Illicit Trafficking in Nuclear and other Radioactive Material (IAEA Nuclear Security Series No. 6);
- Security During the Transport of Radioactive Material (in preparation);
- Protection against an Insider Threat (in preparation).

This paper does not provide a review of these documents, much of whose contents would be more appropriate for inclusion in detailed implementing regulations, rather than in general legislative elements. However, they can also provide useful supplementary material for the development of national legislation on nuclear security.

3. ELEMENTS FOR NATIONAL EXPORT AND IMPORT CONTROLS

A necessary first basis for restraining the illicit trafficking of nuclear materials and related commodities is the development and maintenance of an effective system of national export and import controls. Without such controls, States will lack the legal and administrative basis to prevent unlawful transfers, while enabling lawful commerce related to the peaceful uses of nuclear energy to be conducted in an efficient manner. For most States, having entered into legal commitments under various international instruments to control nuclear transfers to prevent proliferation, these obligations need to be reflected in relevant national laws and regulations. Such controls also help combat illicit trafficking by subnational terrorist or criminal elements. Detailed provisions need not be included in implementing legislation. However, the following basic legislative provisions provide for the necessary legal framework:

— First, the law should contain a clear statement of the objectives of the import and export control regime. This statement can be important in interpreting and applying the law in practice;
— Second, the law should authorize the promulgation of a listing of controlled items, indicating the governmental body responsible for this function (alternatives include the nuclear regulatory body, the departments or ministries of trade, commerce or international relations).
— Third, the law should clearly prohibit the export or import of material, items or technology relevant for the development of nuclear explosives or RDDs without specific authorization by the relevant government authority;
— Fourth, there needs to be a clear assignment of responsibility for implementing export and import controls. In many States, this function is not conducted by the nuclear regulator but by a Ministry or Department having overall responsibility for international trade. In such cases, the law should provide a clear delineation of responsibilities, including participation by the nuclear regulatory body in export or import decisions, in order to reflect technical expertise in the nuclear field;
— Fifth, the basic features of the export and import control system should be outlined. An important feature is the adoption of national lists for controlled materials, items and technology. These lists are more appropriately adopted in the form of regulations, so that they may be more easily revised and updated to reflect technological developments and changes in other relevant circumstances;

- Sixth and seventh, the law can usefully include general licensing criteria for both exports and imports, although more specific requirements may be set forth in regulations. Obviously, the criteria may be different for exports and imports, since different policy objectives are relevant here;
- Eighth, it is extremely important to include the provisions on enforcement of export and import controls, including appropriately stringent criminal or civil penalties for violations, unless they have already been included in another part of the State's legal framework (such as in a general criminal code);
- Ninth, the law should provide that relevant national authorities, including the regulatory body, have the authority to cooperate with other States and relevant international organizations concerning matters relevant to their responsibilities;
- Tenth, and finally, a provision of the law should authorize and mandate the protection of information received in confidence or otherwise necessary to protect for reasons of safety and security.

The following discussion attempts to frame such a set of elements, identifying the international instruments or guidance documents that require or recommend such provisions.[4]

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[4] For purposes of conciseness, the following abbreviations have been used in indicating sources for the various elements:

CPPNM: Convention on the Physical Protection of Nuclear Materials;
Amend.: 2005 Amendment to the CPPNM;
1373: United Nations Security Council Resolution 1373 (2001);
1540: United Nations Security Council Resolution 1540 (2004);
NTC: International Convention for the Suppression of Acts of Nuclear Terrorism (2007);
NPT: Treaty on the Non-Proliferation of Nuclear Weapons (1970);
Tlatelolco: Treaty for the Prohibition of Nuclear Weapons in Latin America;
Rarotonga: South Pacific Nuclear Free Zone Treaty;
Bangkok: South East Asia Nuclear-Weapon-Free Zone Treaty;
Pelindaba: African Nuclear Weapon-Free Zone Treaty;
Central Asia: Treaty on A Nuclear-Weapon-Free Zone in Central Asia;
C of C: Code of Conduct on the Safety and Security of Radioactive Sources (2004);
Guidance: Guidance on the Import and Export of Radioactive Sources (2005);
153: INFCIRC/153 the IAEA's Safeguards System;
540: INFCIRC/540 the Additional Protocol for the Application of IAEA Safeguards;
NSG: Nuclear Suppliers' Group Guidelines in INFCIRC/254, as revised;
ZC: NTP Exporters (Zangger) Committee Guidelines in INFCIRC 209, as revised.

3.1. Element A: Objectives of export and import controls

Controls over the export and import of nuclear and other radioactive material, nuclear related and other relevant equipment and technologies to and from (insert name of State) shall be conducted to advance the following objectives:

— To meet the obligations of (insert name of State) under relevant international instruments entered into by (insert name of State);
— To protect public health, safety and to ensure the security and economic interests of (insert name of State);
— To support international cooperation in the peaceful uses of nuclear energy and ionizing radiation;
— To support international efforts to prevent the proliferation of nuclear weapons and explosive devices or RDDs.

Sources: NPT art. III.2; 1540 para. 3(d); Guidance pt. II; ZC, Memo. A-I; NSG, para. 1.

3.2. Element B: List of controlled goods

In accordance with the international obligations and commitments of (insert name of State), the (insert name of governmental body) shall establish a list of goods subject to control for purposes of export, import or transit into or outside (insert name of State).

Sources: ZC Annex; NSG Annex; 1540 Annex II.

3.3. Element C: Prohibition of unauthorized (unlicensed) transfers

No person or entity shall export, import, trans-ship or transit a controlled item without first obtaining an authorization (licence) from (insert name of responsible governmental body) in accordance with the required procedure.

Sources: CPPNM art. 4; NPT art. III; C of C para. 23; Guidance para. 6.

3.4. Element D: Authority to control nuclear exports and imports

The (insert name of governmental body) of (insert name of State) shall adopt necessary measures, including a system of authorizations (licences), to control the export, import, re-export, transit and trans-shipment of materials, equipment and technology associated with nuclear and other radioactive materials.

Sources: CPPNM art. 3; 1540 para. 3(d); NSG para. 4.

3.5. Element E: Authorizations (licences)

(a) The (insert name of responsible governmental body) shall issue regulations setting forth the details of the authorization (licensing) process for nuclear exports and imports, including:
   (i) The procedures for applying for an authorization (licence), including schedules for reviewing and deciding on applications;
   (ii) A list of material, items and technology requiring an authorization (licence);
   (iii) Provision for periodic revision or updating of lists of controlled items to reflect developments in technology or changes in relevant circumstances;
   (iv) Criteria for the evaluation of an application and issuance of an authorization (licence);
   (v) End user controls;
   (vi) Requirements for notifications prior to shipment of exports where such notification has been determined as necessary;
   (vii) A schedule of fees or charges for granting authorizations (licences);
   (viii) Provisions for trans-shipment of material or commodities otherwise not requiring an export authorization (licence);
   (ix) Requirements for records to be kept regarding authorized activities;
   (x) Protection of confidential information relating to authorized activities.

(b) Review and approval of authorizations (licences) shall be conducted with the participation and concurrence of (insert names of relevant governmental bodies).

Sources: NPT art. III; ZC Memo. A; Guidance part VII.

3.6. Element F: Export authorization (licensing) criteria

Criteria for the granting of an authorization (licence) to export material, items or technology identified by the (insert name of governmental body) as subject to control shall include the following:

— That the receiving State has made a binding commitment to use transferred material, equipment, technology or information for peaceful purposes only;

— That international safeguards will be applied to the transferred material;
— That the receiving State has placed all its nuclear material and nuclear facilities under international safeguards;
— That transfers of previously transferred material and technology to a third State are subject to a right of prior approval by (insert name of State);
— That any reprocessing of supplied nuclear material or alteration of the material in some other way is subject to a right of prior approval by (insert name of State);
— That levels of physical protection that will apply to the exported material will be consistent with those set forth in the Convention on the Physical Protection of Nuclear Material;
— That the applicant has provided information on the end use and end user of material, items or information to be transferred that confirms the legitimate peaceful use of such material, items or information;
— That, for spent nuclear fuel or nuclear waste, the (insert name of State) shall have received prior notification and has consented to the transfer;
— That, for spent nuclear fuel or nuclear waste, the (insert name of State) shall have demonstrated the administrative and technical capability and regulatory structure necessary to manage the material in a safe and secure manner;
— That material will not be transferred to geographical areas where such materials may not be transferred under the terms of international instruments adopted by (insert name of State).

Sources: CPPNM art. 4; C of C para. 25; 153 para. 92; NSG, Rev. 7/part 2, para. 4.

3.7. Element G: Import authorization (licensing) criteria

Criteria for the granting of an authorization (licence) to import material, items or technology identified by the (insert name of governmental body) as subject to control shall include the following:

— That the material, item or technology to be imported is not otherwise prohibited by any law or regulatory provision of (insert name of State);
— That the designated recipient of any imported material, items or technology subject to an authorization (licensing) requirement has been granted the appropriate authorization (licence) consistent with applicable laws and regulatory requirements in (insert name of State);

— That the end user of the imported material, items or technology has the demonstrated technical and administrative capability and resources to use the imported material, items or technology in a safe and secure manner.

Sources: C of C para. 24; Guidance chapter IX; 153 para. 95.

3.8. Element H: Enforcement and penalties

— Investigations of possible non-compliance (violations) of this law and applicable regulations shall be conducted by (insert name of governmental body);
— Any person who fails to comply with (violates) this law, applicable regulations or the terms of any authorization (licence) may be subject to administrative measures established by this law and any applicable regulations of the (insert name of governmental body);
— Any person who fails to comply with (violates) this law, applicable regulations or the terms of any authorization (licence) may be subject to a monetary penalty not to exceed (insert sum in national currency) for each violation;
— Any person who intentionally and with a criminal motive fails to comply with (violates) this law, applicable regulations or the terms of an authorization (licence) may, upon conviction in a court of law, be subject to a fine not exceeding (insert amount in national currency) or imprisonment for a period not exceeding (insert number of) years, or to both a fine and imprisonment.

Sources: CPPNM art. 7; Amend. New art. 7; 1373 para. 2(e); 1540 para. 3(d).

4. ELEMENTS FOR COMBATING ILLICIT TRAFFICKING

Having identified a number of basic elements for export and import control, the discussion will move to an identification of additional elements specifically related to combating illicit trafficking.

Without going into detailed textual analysis, the following portion of this introduction summarizes the basic approach taken in the most relevant instruments in the nuclear security field.

A common feature of several of these instruments is a provision noting the importance of a national legislative and regulatory framework for the protection of nuclear and other radioactive material and associated facilities. In addition, some of these instruments mandate the enactment of national laws prohibiting certain unauthorized activities involving nuclear materials or facilities, including terrorist or criminal acts, calling for the establishment of stringent criminal penalties for violations. Other common requirements in new or revised international instruments for nuclear security involve cooperation and assistance in addressing security issues, sharing relevant information and the protection of sensitive information.

From the most basic perspective, illicit trafficking legislation needs to reflect a number of basic elements. These include:

— Policy against nuclear explosives or RDDs;
— Regulation of physical protection;
— Responsibilities of authorized persons (licence holder);
— Criminal offences;
— Jurisdiction;
— Extradition;
— Penalties;
— International cooperation and mutual assistance;
— Protection of confidential information.

These elements, based on relevant international instruments, are set forth in the form of legislative provisions that could be incorporated into national law. They would, of course, need to be adjusted to reflect national legislative drafting practice and other aspects of national law.

4.1. Element A: Policy against nuclear explosives or RDDs

It is the policy of the Government of (insert name of State) to refrain from providing any form of support to non-State actors that may attempt to develop, acquire, manufacture, possess, transport, transfer, use or threaten to use nuclear weapons or explosive devices or RDDs.

Sources: NPT arts. I and II; NTC arts 2 and 7; 1373 para. 1; 1540 para. 1; Tlateloloco art. 1.1(b); Rarotonga art. 3; Bangkok art. 4.3; Pelindaba art. 3(c); Central Asia arts. 3.1(c) and (d)(iii).

4.2. Element B: Regulation of physical protection

The (insert name of regulatory body) shall establish requirements for the physical protection of nuclear (and other radioactive) materials, including:

— A categorization of material based on an assessment of damage that could result from theft or diversion of a certain type and quantity of material from authorized uses or from sabotage of a facility in which nuclear material is produced, processed, used, handled, stored or disposed of;
— Protection measures necessary for different categories of material;
— Accounting and control measures for nuclear (and other radioactive) material;
— Authorization (licensing) requirements and procedures that include licence conditions for physical protection;
— Inspection and monitoring measures to verify compliance with applicable physical protection requirements;
— Enforcement measures in case of non-compliance or violation of applicable regulations or licence conditions.

Sources: CPPNM art. 5; Amend. New art. 2A; C of C paras. 20-22; NTC art. 18(c).

4.3. Element C: Responsibilities of the authorized person (licensee)

— A person or entity authorized (licensed) to conduct activities or practices utilizing nuclear (or other radioactive) materials is primarily responsible for ensuring the security and physical protection of such materials pursuant to applicable regulations and licence conditions;
— Where there has been a theft, threat of theft or loss of nuclear (or other radioactive) material, the licensee shall:
  • Notify the (insert name of regulatory body) without delay of the circumstances of the incident;
  • Provide written information, including particulars, to the (insert name of regulatory body) as soon as practicable after providing notice;
  • Provide the (insert name of regulatory body) with any additional information requested.

Sources: Amend. New art. 2A, Principle E; C of C para. 8(a).

4.4. Element D: Criminal offences involving nuclear (or other radioactive) material

A person shall be guilty of an offence punishable according to the laws and procedures of (insert name of State) if that person:

(a) Receives, possesses, uses, transfers, alters, disposes of or disperses nuclear (or other radioactive) material in a manner that causes or is likely to cause death or serious bodily injury to any person or substantial damage to property or to the environment;

(b) Steals nuclear (or other radioactive) material;

(c) Embezzles or fraudulently obtains nuclear (or other radioactive) material;

(d) Commits any act constituting the carrying, sending or moving of nuclear (or other radioactive) material into or out of (insert name of State) without lawful authority;

(e) Commits any act directed against a nuclear facility, or an act interfering with the operation of a nuclear facility, where the person intentionally causes, or where the person knows that the act is likely to cause, death or serious injury to any person or substantial damage to property or to the environment by exposure to radiation or release of radioactive substances, unless the act is undertaken in conformity with the laws of (insert name of State);

(f) Commits any act constituting an unlawful demand for nuclear (or other radioactive) material by the threat or the use of force or by any other form of intimidation;

(g) Threatens:

  (i) To use nuclear (or other radioactive) material to cause death or serious injury to persons or significant damage to property or to the environment or to commit an offence described in subparagraph (e);

  (ii) To commit an offence described in subparagraphs (b) and (e) in order to compel a natural or legal person, international organization or any governmental body in (insert name of State) to do or to refrain from doing any act;

(h) Attempts to commit any offence described in subparagraphs (a) through (e);

(i) Participates in any offence described in subparagraphs (a) through (h);

(j) Organizes or directs others to commit an offence described in subparagraphs (a) to (h);

(k) Commits any act which contributes to the commission of any offence described in subparagraphs (a) through (h) by a group of persons acting with a common purpose; such act shall be intentional and shall either:

  (i) Be made with the aim of furthering the criminal activity or criminal purpose of the group, where such activity or purpose involves the commission of an offence described in subparagraphs (a) through (g); or

(ii) Be made in the knowledge of the intention of the group to commit an offence described in subparagraphs (a) through (g).

Sources: CPPNM art. 7; Amend. New art. 7; NTC arts. 2 and 5; 1373 para. 2(e); 1540 para. 3(d).

4.5. Element E: Penalties

— Upon conviction in a court of law, any person found guilty of an offence under (cite relevant Article) of this law shall be subject to imprisonment for a term not to exceed (insert number of) years, or a monetary fine not to exceed (insert amount in national currency), or both, for each offence;
— Where an offence under this law is committed by a legal entity (body corporate) or by a person purporting to act on behalf of a legal entity (body corporate) or an incorporated body of persons and is proved to have been committed with the consent or knowledge of, or to be attributed to any neglect on the part of any person being an officer (responsible employee) of such entity (body), that person shall also be guilty of an offence.

Sources: CPPNM art. 7; Amend. New art. 7; NTC arts. 2 and 5; 1373 para. 2(e); 1540 para. 3(d).

4.6. Element F: Jurisdiction

(Insert name of State) shall have jurisdiction over the offences set forth in (cite relevant Article) as follows:

— When the offence is committed within the territory of (insert name of State) or on board a ship or aircraft registered in (insert name of State);
— When the alleged offender is a national of (insert name of State);
— When the alleged offender is present in the territory of (insert name of State) and is not extradited to any other State asserting jurisdiction.

Sources: CPPNM art. 8; NTC art. 9; 1373 para. 2(e)

4.7. Element G: Extradition (for States requiring an extradition treaty)

— The offences set forth in (cite relevant article) shall be considered as extraditable offences pursuant to any extradition treaty between (insert name of State) and any other State;

— The (include reference to applicable international instruments, e.g. Convention on the Physical Protection of Nuclear Material or International Convention for the Suppression of Acts of Nuclear Terrorism) shall be considered a sufficient basis under the laws of (insert name of State) for extradition of an alleged offender to another State party to the Convention.

Sources: CPPNM art. 11.1 and 11.2; NTC arts. 10 and 13.1 and 13.2; 1373 para. 3(g).

4.8. Element H: Extradition (for States not requiring an extradition treaty)

The offences set forth in (cite relevant article) shall be considered as extraditable offences, subject to the laws and procedures of (insert name of State).

Sources: CPPNM art. 11.3; NTC art. 10 and 13.3.

4.9. Element I: International cooperation and assistance

In the event of theft, robbery or unlawful taking, or credible threat of unlawful taking of nuclear (or other radioactive material) the Government of (insert name of State) shall take appropriate steps as soon as possible to inform other States or international organizations that may be affected of the circumstances of the incident.

— The (insert name of governmental body) shall be the central authority responsible for physical protection of nuclear material and for coordinating recovery and response in the event of any theft or unlawful taking of nuclear or other radioactive material;
— In the event of theft or any other unlawful taking of nuclear (or other radioactive) material, the Government of (insert name of State) shall provide cooperation and assistance to the maximum feasible extent in the recovery and protection of such material to any State or international organization that so requests;
— The (insert name of governmental body) shall provide information on incidents involving the theft, robbery or any other unlawful taking of nuclear (or other radioactive material), equipment and technology to the IAEA under arrangements established by the IAEA.

Sources: CPPNM art. 5(2); Amend. New art. 5; NTS arts. 7 and 14; 1373 para. 3.

4.10. Element J: Confidential information

Article —. Protection of confidential information

— No person shall disclose confidential information, including any such information that is acquired pursuant to the provisions of the Convention on the Physical Protection of Nuclear Material;
— A person who discloses confidential information is guilty of an offence under the laws of (insert name of State).

Sources: CPPNM art. 6; Amend. New art. 2A; NTC art. 7.2; 1373 para. 2(f).

5. CONCLUSIONS

The previous discussion has attempted to review the applicable international instruments and guidance documents relevant for combating nuclear related illicit trafficking. The objective of the review was to identify a number of succinct basic elements that States could use in developing national legal and regulatory frameworks for preventing and responding to illicit trafficking. This approach was adopted because national governments will, for the foreseeable future, remain primarily responsible for the control and response to threats or acts of illicit trafficking involving nuclear and other radioactive materials, and associated items and technology. These elements have been framed in a very succinct manner and will obviously have to be adjusted and possibly expanded to reflect national legislative and regulatory approaches. It must be emphasized, as well, that adoption of effective national measures based on a harmonized international approach is only one aspect of addressing the illicit trafficking threat. International cooperation and assistance in implementing national controls will remain an essential element in preventing nuclear proliferation or terrorism.

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US INITIATIVES TO COMBAT NUCLEAR SMUGGLING

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Abstract

There are a number of initiatives that play a role in combating nuclear smuggling by securing material, detecting incidents or helping to enable countries to prosecute those who violate the laws and regulations governing nuclear and radiological material. The paper covers three key US initiatives. It may sometimes seem confusing, as there are many new initiatives introduced, and governments may get a sense of 'initiative fatigue'. However, it is important to keep pace with, and even one step ahead of, opportunists, profiteers, criminal gangs and terrorist organizations — and those who support them — to be successful in combating nuclear trafficking.

1. TERRORISTS WANT NUCLEAR WEAPONS

Many speakers have addressed the grave consequences of nuclear terrorism, and it is obvious why we need to prevent nuclear smuggling. We all face a worldwide terrorism threat that has repeatedly sought to inflict mass casualties by attacking innocent people. Again, as many speakers highlighted, terrorists want to acquire nuclear weapons and are prepared to use them. To acquire them, they use any means available — theft, intimidation, procurement, barter, recruitment of experts and smuggling by any other means.

2. THREE INITIATIVES

As mentioned, the paper discusses three key US programmes that address nuclear smuggling. There are, of course, many other programmes with the same purpose, but the present focus is on these three.

The first is the Global Initiative to combat nuclear terrorism, which establishes a framework of agreed principles and develops a plan of work with activities to strengthen national capabilities to combat nuclear terrorism.

The second initiative is the G8's Global Partnership, which brings together international partners including 20 donor countries and the European Union, among others, to fund projects to prevent nuclear smuggling.

The third is the Nuclear Smuggling Outreach Initiative (NSOI), which engages specific countries to develop national action plans for combating smuggling.

There are four common elements among these initiatives. The first is that they are all voluntary programmes. Next, each is a collaborative or multilateral effort since the problems of proliferation, including illicit trafficking, are too big, too complex and too diverse for any one country to address on its own. Third, each initiative has evolved over time in response to changing threats to close gaps in nuclear non-proliferation efforts. Finally, each is non-institutional and multilateral — i.e. no permanent secretariat — but rather born out of common interest; non-treaty based and non-United Nations centric. Nevertheless, all three initiatives seek to implement and build capacity in support of international legal frameworks established by the United Nations.

2.1. Global Initiative

The Global Initiative is an 'activities driven' framework aimed at enhancing international cooperation, and integrating and building national capacities of partner nations to combat nuclear terrorism. It is a Russian–US initiative that started in 2006 with about 13 governments. To date, 62 partner nations have endorsed the Statement of Principles and participate in Global Initiative activities.

The Statement of Principles is a framework for partner countries to begin addressing nuclear terrorism including illicit trafficking. In line with this framework, each country signs on to the Terms of Reference, which state that partner nations should work to "improve capabilities to combat nuclear terrorism by providing and receiving assistance to partner states where appropriate to fill capability gaps." This assistance comes in the form of Global Initiative activities which include, but are not limited to, improving the ability to detect illicitly trafficked materials, strengthening national legal authorities to ensure effective prosecution, and promoting information sharing and international cooperation.

One of the goals of the Global Initiative is to better integrate partner country antiterrorism efforts regionally and internationally, as well as to better integrate public and private capabilities. This includes improving communication and coordination across various law enforcement, technical and intelligence agencies within countries and among partner countries. To do so, the Global Initiative has developed some 26 agreed upon plan of work activities which are developed and pursued via workshops, exercises, training seminars and meetings. For instance, in June 2007, the FBI hosted a nuclear terrorism seminar in which 500 law enforcement personnel from around the world participated. In December 2007, there will be additional plan of work activities in China, Australia and Germany related to emergency response techniques, converting HEU fuelled research reactors to LEU fuel, and the development of radiological source registries.

The fourth plenary meeting of the Global Initiative will be held in 2008 to continue the exchange of information, know-how, best practices and incentives for improvement. The focus will be on welcoming new partners and integrating the private sector into the fight against nuclear terrorism.

2.1.1. Global Initiative: Strengthening national capabilities

When countries become a member of the Global Initiative, they make a public statement of support to the framework needed to successfully combat nuclear smuggling. This framework is described in the Global Initiative Statement of Principles which is divided into three categories that are commonly used in describing efforts to prevent illicit trafficking: prevention, detection and response. Prevention entails:

(1) Improvement of security for nuclear and radioactive materials;
(2) Enhancement of security at civilian nuclear facilities;
(3) Denial of safe havens to terrorists, including financial.

Detection includes:

(1) Improvement of the ability to detect nuclear and radioactive substances;
(2) Development of interoperable detection systems.

To have a full response mechanism, one should:

(1) Search and confiscate material, and then maintain safe control of the material;
(2) Strengthen legal authorities to ensure prosecution of nuclear smuggling and related terrorist offences;
(3) Develop technical capabilities to identify and secure smuggled materials and support investigation;
(4) Promote information sharing and international cooperation.

When a country becomes a member of the Global Initiative, they make a commitment to implement, on a voluntary basis, the Statement of Principles. For example, Global Initiative partners agree to improve the security of nuclear material and radioactive substances, to improve their ability to detect nuclear and radioactive materials, and to strengthen legal authorities to effectively prosecute nuclear smuggling and related offences. One of the goals of Global Initiative participation is that the skills, lessons learned and best practices of one nation will be shared with other governments and vice versa.

2.2. Global Partnership: Internationalizing the fight against WMD proliferation

Following the terrorist attacks of 11 September 2001, the Global Partnership against WMD proliferation was adopted by the G8 in 2002 at the Kananaskis Summit in Canada. The Global Partnership is a truly unique initiative that secured the commitment of G8 members to fund $20 billion on non-proliferation and antiterrorism projects over ten years. The USA agreed to fund half of the initiative and is now spending well over one billion dollars per year to meet its Global Partnership pledge.

The Global Partnership's priority mission is to keep WMDs out of the hands of terrorists or States which support them. Prior to 2002, the focus of the programme that preceded the Global Partnership — the Cooperative Threat Reduction programme — was on WMD threat reduction in the Russian Federation and the former Soviet Union where the problem was seen as most serious and in most need of remediation. Projects included warhead dismantlement, chemical weapons destruction, elimination of strategic missiles and decommissioning submarines. Since Kananaskis, the focus is now expanding as the threat moves worldwide.

The events of 11 Setptember 2001 were the primary catalyst for the Global Partnership and helped kick-start new thinking about the threats we all face and what we can do to reduce them. New areas of engagement include conversion of research reactors from HEU to LEU fuel and securing radiological sources.

2.2.1. The future of the Global Partnership

The year 2007 marks the mid-point of the Global Partnership's ten year commitment. This year, under Germany's G8 presidency, we conducted an assessment of the Global Partnership and, among other things, concluded that the G8 should explore new and emerging global threats consistent with

Kananaskis principles while not abandoning efforts in the Russian Federation and former Soviet Union.

Other US programmes under the Global Partnership include the MPC&A, Second Line of Defense and Global Threat Reduction Initiative programmes, as well as the Cooperative Threat Reduction programme and EXBS, and scientist redirection efforts. As we continue to see intent to acquire nuclear and radioactive material illegally and for malevolent purposes, we will continue to invest in these programmes.

2.3. Nuclear Smuggling Outreach Initiative (NSOI): Encouraging national action and matching donors to specific projects

The NSOI seeks to coordinate and cooperate with countries where the smuggling threat is deemed to be greatest. It does so by assisting countries to improve their abilities to prevent, detect and respond to incidents of nuclear smuggling. A four step methodology of engagement is used with each individual State:

(a) The NSOI identifies those countries seen to be at greatest risk of smuggling of nuclear and radioactive materials in or through their territories;
(b) The NSOI makes an assessment which identifies gaps in existing anti-smuggling capabilities and then works with the partner government to negotiate a joint action plan specifying in detail the agreed steps to address priority needs;
(c) The NSOI team and partner government also agree on a list of assistance projects focused on those steps in the plan that the partner nation cannot implement alone;
(d) For those actions a country does not have the financial or other means to implement, the NSOI team engages US and international assistance providers to seek donors for each project and to coordinate among these donors to ensure that the full set of contributions is provided in a coherent manner.

2.3.1. Countries initially engaged through the NSOI

As stated earlier, a joint action plan is developed for each country the NSOI engages. The joint action plan includes priority steps to successfully combat nuclear smuggling and then ties priority assistance projects to those steps to ensure they can be accomplished. For example, in Ukraine, we agreed on 30 steps including consolidating radioactive source storage facilities in the

Chernobyl exclusion zone. In Kazakhstan, where 34 steps were agreed, one of the projects that supports these steps is providing equipment and training for orphan source search and secure missions. In Georgia, 50 priority steps were agreed, including development of a joint maritime coordination centre to integrate various efforts among different agencies involved in maritime security. Note that the NSOI helped fund participation in the International Technical Working Group (ITWG) on Nuclear Forensics to help countries improve their ability to identify stolen material.

NSOI projects cover the entire span of smuggling prevention activities ranging from securing radiological sources, to installing detection equipment at border crossings and other points of entry, to enhancing law enforcement response efforts. To date, the NSOI has secured contributions from 12 international partners including Canada, France, Japan, New Zealand, Norway, the Republic of Korea, Sweden, Ukraine, the United Kingdom, the European Commission, the IAEA and the United Nations Office on Drugs and Crime.

Future NSOI efforts include continuing to solicit interest in other regions including South Asia, Africa, the Middle East and the former Soviet Union. The initiative seeks to engage where threats are most prevalent which may require a more worldwide effort.

3. OTHER IMPORTANT EFFORTS TO STOP NUCLEAR SMUGGLING

While I have focused on just three smuggling prevention initiatives, I would be remiss not to highlight some other important international programmes to prevent nuclear terrorism.

One of the most important is the ongoing effort to implement United Nations Security Council Resolution 1540 which was adopted in 2004 [1]. This binding resolution requires that all governments put in place a broad set of measures to prevent terrorists from acquiring WMDs. The USA calls on all governments to fully implement this resolution. Contributions to the three initiatives above help governments meet their 1540 obligations and add to their capabilities of combating nuclear smuggling.

Another important element is international forensics cooperation, particularly through the ITWG on Nuclear Smuggling. Through the ITWG, technical experts, law enforcement officials, policy makers and diplomats from interested governments cooperate to identify best practices in the field of nuclear forensics.

The International Convention for the Suppression of Acts of Nuclear Terrorism [2] requires States to develop legal frameworks to prevent and respond to acts of nuclear terrorism, and to effectively prosecute those who perpetrate such acts. It also outlaws specific acts of nuclear terrorism and is intended to protect against attacks on a range of targets, including nuclear power plants and reactors. It also applies to threats and attempts to commit such crimes. It calls on governments to share certain types of information, and provide assistance for investigations and extraditions. There are presently 115 signatories and 29 State parties to the Convention.

The Proliferation Security Initiative (PSI) provides an important cooperative mechanism for about 80 countries to prevent the proliferation of WMDs through interdiction of illicit/dangerous cargo (land, sea, air) using their national legal authorities and acting consistently with relevant international law and frameworks.

Again, this is not meant to be an exhaustive list as the Convention on the Physical Protection of Nuclear Material [3], Second Line of Defense, the Container Security Initiative and the Code of Conduct on the Safety and Security of Radioactive Sources [4] could have been included.

4. US RESPONSE TO TRAFFICKING INCIDENTS

It is important to mention another US Government group that plays a significant role in preventing nuclear smuggling, the Nuclear Trafficking Response Group (NTRG). This group serves as the mechanism the US Government uses to internally coordinate its response to international incidents and to cooperate with other governments to respond to smuggling incidents. The NTRG is chaired by the US Department of State and consists of representatives from the US interagency who can respond to international illicit trafficking incidents of nuclear and radioactive material overseas. This capability operates 24 hours per day, 365 days per year.

4.1. NTRG functions

The NTRG carries out multiple functions to respond to international nuclear trafficking incidents. The NTRG helps other governments identify, locate and secure smuggled material; acquire samples for forensics; provide expert testing of material (if requested); provide prosecutorial assistance (if requested); and develop associated information (if requested). All of these tasks are performed through interagency coordination and collaborating closely with the individual country. To aid in collaboration, governments who seek US Government assistance should contact the US Embassy which will then contact the NTRG to facilitate the request.

In the experience of the NTRG, it has been found that there are three core areas or priorities in responding effectively to smuggling incidents: (1) removing all the trafficked material from circulation; (2) prosecuting those involved; and (3) looking upstream to ascertain the source of the diversion.

5. WORKING TOGETHER TO BUILD ON THESE EFFORTS

To conclude, virtually everything done in the realm of non-proliferation, counterproliferation and antiterrorism can contribute in some way to our collective effort to prevent illicit nuclear trafficking. There is a kind of international non-proliferation architecture that exists, not out of some pre-existing blueprint, design or plan, but one that has evolved over time in response to the changing threat. It involves improving on existing instruments and continued learning from one another. As we learn, we have to be nimble and agile, and better than those who seek to exploit weaknesses or gain in our effort to prevent, detect and respond to illicit nuclear trafficking. The USA is willing to learn from others and willing to assist others who seek our assistance. Through this cooperation, it is hoped we can be successful in this important collaborative effort.

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THE NUCLEAR SECURITY PROGRAMME IN THE EUROPEAN UNION
Challenges, instruments and R&D support

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Abstract

Three strategic objectives are outlined in the European security strategy. Addressing the threats is the first. Building security in Europe's neighbourhood is the second objective. The third strategic objective is the establishment of "an effective multilateral system". A major challenge for the security of the European Union and its partners, therefore, will be to identify and carry out effective measures to counter these threats. To tackle these challenges, the European Union has developed a set of instruments. The nuclear security strategy pursues similar objectives to some elements of the European Union security strategy against the proliferation of weapons of mass destruction. These have been developed and implemented along the traditional three phases: (1) identification, analysis and prevention of the risk (e.g. for the diversion of sensitive material) (first line of defence); (2) detection and early warning of the risk in course (e.g. the theft of nuclear material) (second line of defence); and (3) reaction to and remediation of the risk (e.g. response plan for illicit trafficking) (third line of defence). The paper focuses on the nuclear and radiological threats, and the necessary instruments the European Union disposes to tackle these challenges. The seventh Framework programme of the European Commission also addresses the security aspects in terms of R&D projects and training sessions. These activities are also described with a focus on the nuclear security R&D projects and training sessions of the Joint Research Centre Euratom programme. As nuclear security has a strong international dimension, the collaboration with traditional partners such as the IAEA or the US Department of Energy is also highlighted here.

1. INTRODUCTION

The 2003 European security strategy [1] states that security is a precondition for development. Conflict not only destroys infrastructure, including social infrastructure, it also encourages criminality, deters investment and makes normal economic activity impossible. Europe faces threats which are more diverse, less visible and less predictable:

- — Terrorism puts lives at risk and terrorists are willing to use violence to cause massive casualties;
- — Proliferation of weapons of mass destruction is potentially the greatest threat to our security. Advances in the biological sciences may increase the potency of biological weapons in the coming years, and attacks with chemical and radiological materials are also a serious possibility;
- — Regional conflicts can lead to extremism, terrorism and State failure; they provide opportunities for organized crime. Regional insecurity can fuel the demand for weapons of mass destruction;
- — State failure is another source of threat. Bad governance — corruption, abuse of power, weak institutions and lack of accountability — and civil conflict corrode States from within. Collapse of the State can be associated with obvious threats such as organized crime or terrorism;
- — Europe is a prime target for organized crime. This internal threat to European Union security has an important external dimension: cross-border trafficking of drugs, women, illegal migrants and weapons accounts for a large part of the activities of criminal gangs. It can have links with terrorism.

Addressing the threats is the first of three strategic objectives outlined in the strategy. Building security in Europe's neighbourhood is the second objective derived from the fact that even in an era of globalization, geography is still important. The strategy points out that "neighbours who are engaged in violent conflict, weak states where organized crime flourishes, dysfunctional societies or exploding population growth on our borders all pose problems for Europe."

The third strategic objective is the establishment of "an effective multilateral system": "a stronger international society, well functioning international institutions and a rule-based international order." The centre of that system is the United Nations, hence "equipping it to fulfil its responsibilities and to act effectively, is a European priority."

A major challenge for the security of the European Union and its partners, therefore, will be to identify and carry out effective measures to counter the threats described previously, knowing that due to common threats, shared with all our closest partners, international cooperation is a necessity. The European Union must, therefore, pursue its objectives both through multilateral cooperation in international organizations and through partnerships with key actors.

The nuclear security strategy pursues similar objectives to some elements of the European Union security strategy against the proliferation of weapons of mass destruction. These provide a comprehensive approach to nuclear security and have been developed and implemented along the traditional three phases: (1) identification, analysis and prevention of the risk (e.g. for diversion of the sensitive material) (first line of defence); (2) detection and early warning of the risk in course (e.g. the theft of nuclear material) (second line of defence); and (3) reaction to and remediation of the risk (e.g. response plan for illicit trafficking) (third line of defence). Furthermore, the enlargement of the European Union has recently modified its borders, expanded the risk and obliged the European Union to work with new countries. As nuclear security has a strong international dimension, the collaboration with traditional partners, such as the IAEA or the US Department of Energy (DOE), has been strengthened and broadened to areas that had not been covered by existing agreements.

In this paper, we will focus on the nuclear and radiological threats, and the necessary instruments the European Union disposes to tackle these challenges. The seventh Framework programme of the European Commission also addresses the security aspects in terms of R&D project and trainings. These activities are also described with a focus on the nuclear security R&D projects and trainings of the Joint Research Centre (JRC) Euratom programme [2].

2. EUROPEAN UNION INSTRUMENTS

The activities in the field of security are financed through the so-called European Union instruments. There are five geographic instruments: the first corresponding to the developing countries (Development Cooperation Instrument (DCI)), a second for the candidate and potential candidate countries for European Union accession (Instrument for Pre-accession Assistance (IPA)), a third for neighbouring countries not expected to become European Union members (European Neighbourhood Policy Instrument (ENPI)), a fourth for cooperation with industrialized countries, and finally the Instrument for Nuclear Safety Cooperation (INSC).

There are another four instruments dubbed ‘horizontal’ that deal with four major areas of European Union external assistance on a global basis. These are macroeconomic assistance, the European Instrument for Democracy & Human Rights (EIDHR), the Instrument for Stability (IfS) and the Humanitarian Aid Instrument, of which the first and the last already existed in the previous budget.

One final feature is the continuation of five development programmes which will now be part of the two geographic instruments that include the DCI and ENPI, and will also be available for the large group of developing countries for which funds are still kept outside the European Union's budget, that is the African, Caribbean and Pacific Group of States (ACP) that are funded from the separate European Development Fund (EDF). The one other important instrument that is not included in the description because it is not funded by the European Commission but by the Council Secretariat is the Common and Foreign Security Policy which covers European Union expenditure on foreign policy and security.

The main instruments dealing with nuclear security issues are described in the following sections.

2.1. The Instrument for Stability (IfS)

The IfS [3] provides the European Union with funds and mechanisms to address global and transregional threats with the following long term objectives:

— To develop long term Community actions to counter global and transregional threats arising from organized crime, trafficking, proliferation of nuclear, biological and chemical agents, and also threats to critical infrastructure and public health, while at the same time contributing to broader Community development and external policy objectives;
— To contribute to the implementation of European Union strategies, such as the European security strategy and the strategy against proliferation of weapons of mass destruction;
— To assist partner countries in their efforts to tackle global threats through capacity building and international cooperation measures;
— To complement the Common Foreign and Security Policy (CFSP).

Scope for action:

— To support international efforts to address the proliferation of weapons of mass destruction, in particular, through effective control of chemical, biological, radiological and nuclear materials and agents, control of dual-use goods, and the redirection of weapons scientists' knowledge towards peaceful activities;
— To support global and transregional efforts to address the threats posed by trafficking, terrorism and organized crime. The IfS will be the primary

instrument for addressing the non-proliferation of weapons of mass destruction;
- To complement actions from national and regional programmes which aim at strengthening local and regional capacities of partner countries;
- When appropriate, to focus on multipurpose projects addressing multiple threats at the same time.

To achieve these objectives, an Expert Support Facility (ESF) is being created under the IfS. The ESF will be managed and run by the JRC and will be in charge of the following tasks:

- Identification of key areas of intervention (thematic and geographic);
- Assessment of risk situations with recommendations for action;
- Immediate support to beneficiaries for actions related to the transregional threats (training, technical support, etc.);
- Consistency with national and regional programmes.

The budget allocated for these actions will cover the period 2007–2013. It should be mentioned that this instrument covers the previous activities related to non-proliferation undertaken under the TACIS programme such as measures to counter nuclear trafficking.

2.2. TACIS and the Instrument for Nuclear Safety Cooperation (INSC)

The running TACIS safeguards support programme 2005–2010 proposal is larger in terms of budget as well as geographic distribution. Although it completes previous projects, and reinforces and sustains past activities, it mainly addresses new challenges with the same objectives: the dissemination of a safety culture by the transfer of know-how and knowledge, and the enforcement of nuclear security. Fifteen projects within the seven a.m. countries will still be implemented. The new series of projects continues dealing with safeguards issues, tracking nuclear material by improving the NMAC of the fuel cycle to avoid diversion and possible dissemination. However, as already mentioned, it also addresses new challenges in particular with the situation in the north-west of the Russian Federation where nuclear spent fuels from submarines and icebreakers are waiting to be evacuated.

INSC (2007–2013) [4] finances measures to support the promotion of a high level of nuclear safety, radiation protection and the application of efficient and effective safeguards of nuclear material in third countries, and it is planned to replace the TACIS programme dealing with these issues.

2.3. Instrument for Pre-Accession Assistance (IPA)

The main objective of the IPA programme [5] is to help candidate and potential candidate countries (Albania, Bosnia and Herzegovina, Croatia, the former Yugoslav Republic of Macedonia, Montenegro, Serbia including Kosovo (as defined in United Nations Security Council Resolution 1244 [6]), and Turkey) — the beneficiaries — to face the challenges of European integration, to implement the reforms needed to fulfil European Union requirements and progress in the stabilization and association process, and to lay the foundations for fulfilling the Copenhagen criteria for European Union membership. The IPA replaces the PHARE, CARDS, MEDA and ISPA financing instruments that ended on 31 December 2006.

The IPA regional and horizontal programme comprises an action specifically devoted to nuclear safety and radiation protection, including prevention and combating of illicit trafficking of nuclear materials and radiation sources. Enhancement of the security of sealed radioactive sources is also part of this horizontal programme. As for the former PHARE horizontal programme on nuclear safety which, in the recent past, supported investment projects in these domains in Bulgaria, Romania and Croatia, the IPA should eventually finance the delivery of appropriate equipment (e.g. stationary portal monitors) and support the construction of facilities (e.g. storage facilities for sealed radioactive sources) in candidate and potential candidate countries over the next years. In 2007, the IPA horizontal programme on nuclear safety and radiation protection supported the joint management with the IAEA of the transport of high enriched uranium spent nuclear fuel from the Vinča Institute near Belgrade, Serbia, to the Russian Federation, the fitting out of a processing facility for radioactive waste at Vinča, and several exploratory studies notably aiming to identify the needs of IPA eligible countries in terms of prevention and combating of illicit trafficking of nuclear materials and improvement of the security of sealed radioactive sources.

2.4. External European Union action: The Joint Actions

In the framework of the CFSP and, more specifically, in the context of the implementation of the European Union strategy against weapons of mass destruction proliferation, the Council has so far adopted three Joint Actions (JAs) (under the Treaty on European Union [7]) in support of the IAEA nuclear security fund. The financial contributions provided in these JAs have made the European Union the major donor to this IAEA programme, which is aimed at preventing acts of nuclear terrorism. European Union assistance through the IAEA covers three main areas of nuclear security: enhancing physical protection of nuclear material and facilities, protection and control of radioactive materials and measures against illicit trafficking in nuclear and radioactive materials.

In 2003, the European Council decided to finance the first JA to be implemented by the IAEA. The first JA targeted the Balkans, Central Asia and Caucasus. The second JA focused on the Middle East and Africa. A third one was submitted and approved by the Council early in 2006. The fourth will deal with south-east Asia. Besides, as a 'crash' programme, a specific JA is about the support of IAEA activities in relation with its agreement with the Democratic People's Republic of Korea in the framework of the "six parties" agreement.

The JAs aim to assess the situation in the individual countries and, based on the results, support the enhancement of nuclear security in selected countries by:

— Developing necessary infrastructure including a legal and regulatory framework;
— Improving physical protection;
— Reducing threats for other radioactive materials by, for example, identification, control and safe storage of orphan sources;
— Increasing capabilities to detect and respond to illicit trafficking of nuclear and radioactive materials at borders.

3. JRC R&D ACTIVITIES IN THE FIELD OF NUCLEAR SECURITY

The JRC contributes to nuclear security in the areas of safeguards, non-proliferation, the fight against illicit activities involving nuclear and radiological material, and evaluating the dangers arising from a radiological dispersal device (RDD).

These activities mainly consist of science based technological support, and have been conceived and developed in three phases: (1) identification, analysis and prevention of the risk (first line of defence); (2) detection and early warning of the risk in course (e.g. the theft of nuclear material) (second line of defence); and (3) reaction to and remediation of the risk (e.g. response plan for illicit trafficking) (third line of defence). The training sessions remain an important horizontal activity in this nuclear security strategy covering the three lines of defence. As this strategy has an international dimension, the JRC is strengthening its collaborations in this field with international and regional organizations, such as Europol, INTERPOL and the IAEA, as well as with major contributors.

3.1. First line of defence: Prevention

3.1.1. Inventory of nuclear and radioactive materials

The fundamental pillar of the Nuclear Non-Proliferation Treaty (NPT) [8] is based on the assumption that the first line of defence consists of prevention of the diversion of relevant materials. While the physical protection prevents external attempts, insiders can also be part of the process. To limit the risk of this second possibility, a clear inventory with corresponding identification of sensitive materials must be available on a regular basis. The JRC proposes to build upon past projects aimed at providing modern tools for the inventory and follow-up of radioactive and nuclear materials. The traceability of radioactive sources is also relevant due to their potential attractiveness for terrorist groups.

3.1.2. Import and export control of dual-use materials

Another important aspect of non-proliferation of weapons of mass destruction is the control of useful technologies. United Nations Security Council Resolution 1540 [9] obliges all States to establish appropriate domestic controls over materials related to nuclear weapons. Sensitive materials should be tracked when being exported to ensure that the intended use of the equipment is not diverted to illegal activities. Based on its work in anti-fraud and illegal transport identification (e.g. the Contraffic project), further skills are being developed by the JRC in the area of import and export control of dual-use materials.

3.1.3. Support to secure declassified/mothballed/obsolete facilities

When there is a need to verify the proper use — or putting out of use of, for example, declassified facilities — the JRC can contribute to the assessment of the sensitive parts, equipment and materials and, can provide support, for example, the installation of monitoring equipment to verify the absence of non-proper use of the installations and/or the impossibility to return the facilities to their original use.

3.2. Second line of defence: Detection

3.2.1. Detection and monitoring technologies

Detection and monitoring will continue to be a core activity of the second line of defence against radioactive and nuclear materials smuggling. Improvement and validation of new technologies is part of global security enhancement and is already supported by the IAEA as well as major international actors in the field. The JRC has a long experience in non-destructive techniques for the detection and monitoring of nuclear and radioactive materials. This experience can be used to design, validate and benchmark specific detection techniques and monitoring equipment.

3.2.2. Border control and response plan

Deploying detection equipment at the outer borders of the future enlarged European Union will continue, completed by the implementation of a national response plan to illicit trafficking of nuclear and radioactive materials. This integrated response plan will be based on the Model Action Plan jointly developed by the JRC, the IAEA and the International Technical Working Group (ITWG).

3.2.3. Regional cooperation in combating illicit trafficking

Illicit trafficking of nuclear and radioactive materials is an international concern. Seized materials often do not originate from the country in which the seizure is made. Sharing of information and formal cooperation is a key aspect of the fight against illicit trafficking. Based on past experience, the JRC would like to enhance international cooperation in fighting against illicit trafficking of nuclear and radioactive materials, for example, by supporting common border control programmes including sharing of relevant information and, where relevant, even exchange of material and investigation protocols (e.g. through the use of regional competence centres for specific investigations). Building confidence during the initial phase, the cooperation will be extended later on. The JRC's capabilities in open source information and country profiles can be part of extended support provided to regional cooperation.

3.2.4. Detection of undeclared activities

Apart from the terrorist threat, possible violation of the NPT is a subject that has recently come to light. Using official and declared facilities of a civil fuel cycle, a dedicated, short campaign can lead to the production of weapons grade nuclear material, for example, by increasing the uranium enrichment value. The JRC is already participating to detect such undeclared activities by supporting the IAEA in the implementation of the Additional Protocol [10]. In particular, the JRC has gained relevant experience in environmental sampling which allows the detection of nuclear materials and their categorization. As for the nuclear country profiles discussed below, the JRC is also experienced in the interpretation of satellite images for verifying the absence of undeclared activities.

3.2.5. Nuclear country profiles

As well as undeclared activities, the Additional Protocol aims at the detection of undeclared facilities. Pre-assessment of the individual national situation is necessary to prioritize the efforts and to focus on relevant countries. The JRC has gathered quite some skills in the assessment of the nuclear profiles of certain countries in view of evaluating the risk for proliferation threats. Open source information, satellite imaging and Internet screening are combined with expert judgement and knowledge of the nuclear fuel cycle materials and installations to compile such nuclear country profiles.

3.3. Third line of defence

3.3.1. Nuclear forensic science

Based on the Model Action Plan jointly developed by the G8 ITWG, where the JRC is active, and the IAEA, the response to illicit trafficking includes the determination of the origin of the seized material, the intended use and the possible trafficking route (with use of the nuclear materials and possibly a literature database). In particular, this third line of defence allows us to identify weaknesses in the facility where the material has been diverted and to take corrective measures accordingly. For more than ten years now, the JRC has developed ad hoc capabilities and is recognized as a centre of excellence.

3.3.2. Threat assessment of nuclear and radioactive dispersion events

One of the possible terrorist threats is the fabrication and use of an RDD, also known as a ‘dirty bomb’, in particular in an urban area. In such an event, the efficiency of the response would be linked to the best and quickest evaluation of the radiological situation after the event. The JRC has developed competences in the modelling and real time measurements of nuclear and radioactive dispersion. Potential extension towards remediation activities can be envisaged building on the competence in the area of chemical toxic substances.

3.4. Related training

In the frame of the support to combat illicit trafficking of nuclear and radioactive materials, a lot of equipment has been delivered. Frontline officers of law enforcement services (e.g. customs, border guards, police and intelligence) are frequently not trained in the use of available border monitoring equipment. Training of these officers is therefore critical to the success of any measures put in place for the detection of illicit trafficking. To efficiently use this sensitive equipment and technology, intensive and periodic training has to be provided. Moreover, corresponding procedures and management must be in place to respond to the increased awareness of the threat. The JRC will continue to provide expertise and training in nuclear forensics, a powerful tool to identify the origin of the seized nuclear material and provide feedback on potential security weaknesses.

Advice or training can also be provided on the protective measures required to deal with classical forensics investigations on nuclear, radioactive or contaminated materials and/or persons. This can be focused on decontamination and/or safe sampling without altering the evidence and on the execution of classical forensic analysis in the presence of high levels of radiation or contamination.

4. INTERNATIONAL COLLABORATION

The international community is deploying a large effort in addressing the issue, in particular, by supporting beneficiary countries in developing, enhancing and upgrading their capabilities. In particular, equipment for the detection of nuclear and radioactive materials at crucial nodal points is provided worldwide by the major donor States.

The European Commission, in particular through its JRC, is a key player in the field, as demonstrated in the TACIS programme and as foreseen in the IfS. Under these two programmes, the JRC is supporting the fight against illicit trafficking of nuclear and radioactive materials, and is implementing specific projects dedicated to border monitoring. Knowing the size of the geographical area to be covered and the limited resources available, the international coordination between major contributors was addressed at an early stage, in particular through the creation of an ad hoc working group under the auspices of the IAEA in late 2005.

This Border Monitoring Working Group (BMWG), where the JRC represents the European Commission beside the IAEA, the USDOE and the European Council Secretariat General, shares all relevant information to identify gaps and avoid duplications. Technical issues, recipient institutions and geographical implementation are periodically discussed within the group. The members of the BMWG also recognize the importance of the training of law enforcement services and frontline officers for the success of any project related to nuclear and radioactive materials security, and are willing to share available resources to optimize the impact of their effort.

The JRC is currently implementing a series of projects in the Russian Federation, Armenia, Ukraine, Republic of Moldova, Georgia and Azerbaijan to support the fight against illicit trafficking of materials in the recipient countries. Detection equipment for borders and mobile specialized teams will be provided with corresponding training. International cooperation will be enhanced by common training sessions and demonstration exercises.

5. CONCLUSION

European Union security has both internal and external dimensions:

— Internally it includes: enhanced cooperation and coordination between Member States and between the European Commission and Member States; increased efficiency; a link between research, development and operational use; trainings; standards for technologies, procedures, methods and processes; coordination between the numerous and fragmented research programmes;
— Externally it includes: enhanced cooperation with potential partners; a harmonized technical approach; and an integrated training approach.

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BUILDING UP QATAR'S CAPABILITIES TO COUNTER ILLICIT TRAFFICKING OF NUCLEAR AND RADIOACTIVE MATERIALS*

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Nuclear and radioactive materials have been used for decades to provide for a better quality of life. They are used in industry, medicine, agriculture and research. However, after the tragic events of 11 September 2001 and what followed, the security of these materials became of great concern to the international community as should these materials fall into the wrong hands, the consequences could be devastating. While Qatar does not have any nuclear materials, radiation sources are used in the medical and industrial sectors. In order to regulate their use, Qatar issued Law No. 31 in 2002 on radiation protection. The law was followed by several regulations on radioactive waste management and the safe transport of radioactive materials. However, while the law addresses radiation safety very well, it does not fully cover the security issues. Recently, the cabinet of ministers in Qatar agreed to the principles of the Code of Conduct on the Safety and Security of Radioactive Sources. By so doing, Qatar fully supports and endorses the IAEA's and international efforts to enhance the safety and security of radioactive sources. Qatar is also working towards following the guidance contained in the revised Code. Qatar signed an arrangement for cooperation in the field of nuclear security with the IAEA on 8 June 2007. In order to fulfil its obligations to the world community, Qatar decided to enhance its capabilities to counter illicit trafficking of nuclear materials by establishing an advanced and comprehensive border monitoring network. The network will be established in two phases:

(a) Phase I: In this phase, all materials entering the country will be monitored for radioactivity content whether the intention is illicit trafficking or

* The full paper was not available for publication. The synopsis appears in its place.

simply unauthorized movement of these materials. To achieve this, Qatar will install 13 vehicle radiation portal monitors at:

(i) The land crossing;
(ii) The airport cargo terminal;
(iii) The main seaport and the fisherman port in Doha;
(iv) The seaports in the Mssaeed industrial city;
(v) The Ras Laffan industrial complex.

In addition, four pedestrian radiation portal monitors will be installed at the Doha passenger terminals and one pedestrian radiation portal monitor will be installed in the passenger terminal at the commercial port in the Mssaeed industrial city. The monitors will be connected via a real time network to the operation room of the Ministry of Interior and to the early warning centre at the Supreme Council for the Environment and Natural Reserves. All these sites will be equipped with multipurpose handheld radioisotope identifier devices (RIDs), neutron search devices (NSDs) and personal radiation detectors (PRDs). This phase will include comprehensive training of all security and customs personnel by IAEA experts. It is expected that this phase will be completed by July 2008;

(b) Phase II: In this phase, similar equipment will be installed at these locations to monitor outgoing materials or passengers. It is planned that Phase II will commence one year after the commissioning of the Phase I equipment. It is hoped that this year will give the concerned staff sufficient time to become familiar with the equipment and to resolve outstanding issues.

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UNITED KINGDOM COOPERATIVE NON-PROLIFERATION PROGRAMMES IN THE FRAMEWORK OF G8 INITIATIVES*

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The United Kingdom Government Global Threat Reduction Programme is the United Kingdom Government's principal cooperative non-proliferation programme. It has a budget of around £35 million per annum and is managed across three United Kingdom Government departments. The Foreign and Commonwealth Office has overall policy responsibility for the programme, the Ministry of Defence operates the programmes focusing on chemical and biological threat reduction projects, and the Department for Business, Enterprise and Regulatory Reform operates the programmes focusing on radiological and nuclear threat reduction. Funding for the programmes is drawn from the overall United Kingdom Kananaskis Summit commitment of expenditure of up to US $750 million over ten years from 2002.

The principal areas of activity of the programme are as follows:

— The north-west of the Russian Federation, focusing on the management of spent fuel from decommissioned submarines in the Kola Peninsula;
— Chemical weapons destruction focusing on assistance to destroy chemical weapons stockpiles held at the Schycshe facility in the Urals region of the Russian Federation;
— Programmes to assist in the provision of sustainable employment for former weapons scientists;
— Programmes in collaboration with the US Department of Energy (DOE) to assist in the shutdown of plutonium production reactors dating from the era of the former Soviet Union;

* The full paper was not available for publication. The synopsis appears in its place.

— A portfolio of projects to enhance security of holdings of nuclear and radiological materials.

The portfolio of nuclear security projects seeks to address smuggling through tackling the first line of defence. The programme focuses on physical protection upgrades, mainly, but not exclusively, focusing on the creation of inner security boundaries around key material holdings. The provision of training and improvements in security culture are also a key aspect of the programme. Sustainability of equipment and support following project completion is also a critical factor, and the United Kingdom will be seeking to draw on and learn from current best practice to ensure that physical infrastructure improvements are maintained and upgraded over a long period of time. The projects are implemented both through bilateral cooperation (e.g. in the Russian Federation) and through collaboration with the USDOE and the IAEA Nuclear Security Fund. The United Kingdom very much appreciates the benefit that such collaboration can bring, especially in assisting with the prioritization of projects and in widening the geographical reach of the current portfolio of projects.

Projects are currently underway in the Russian Federation, Ukraine, Tajikistan, Armenia, Kazakhstan and Belarus. Work is actively under way to consider extending the programme to other key priority regions.

Through the experience of operating the programme, it is clear that the following issues are of particular importance:

— Prioritization of projects, especially across a wide geographical area;
— Sustainability of upgrades already completed;
— Effective legal frameworks for collaboration;
— The importance of donor coordination to ensure projects are not double funded or that they are not technologically incompatible with each other;
— Highlighting the success of the collaboration.

More can be read about the United Kingdom Global Threat Reduction Programme on the web site (http://www.berr.gov.uk/energy/non-proliferation/global-threat-reduction/index.html).

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AVIATION SECURITY CHALLENGES AND ACTIONS BY THE INTERNATIONAL CIVIL AVIATION ORGANIZATION

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Abstract

The paper provides information on the legal and technical elements of the International Civil Aviation Organization (ICAO) Aviation Security Programme as well as the security of travel documents. It examines the most recent threats to civil aviation such as the terrorist acts of 11 September 2001, the threat to civil aviation posed by the use by terrorists of 'man-portable air defence systems' (MANPADS) and the most recent emerging threat reported by the United Kingdom authorities on 10 August 2006 which concerned an alleged terrorist plot involving liquid explosives to be carried on board civil aircraft flying across the North Atlantic. The paper also describes subsequent actions by ICAO, its contracting States and concerned international organizations to meet the challenges posed by these threats.

1. INTRODUCTION

Air transport makes an enormous contribution to the world economy; it provides powerful support for the development of nations and its growth is essential for the economic and social activities of States. What makes aviation different from other modes of transport and why does it attract so much attention? The benefits of high mobility, high profile and large passenger numbers bring with it disadvantages. Air transport has become an attractive target for various terrorist groups. Since the impact of an incident is enormous, it creates worldwide attention, as demonstrated by dramatic hijackings over several decades, the bombing of Pan Am flight 103 in December 1988 and the horrific terrorist attacks of 11 September 2001. On that day, for the first time in history, domestic flights were easily re-routed and aircraft used as weapons of destruction.

2. CHALLENGES POSED BY THE RECENT THREATS TO CIVIL AVIATION

The acts of 11 September 2001 have since set us the challenge of identifying and responding effectively and comprehensively to new and emerging threats to civil aviation, to restore public confidence in air travel as well as promoting the health of air transport in order that it can continue to make its vital contribution to the world economy. Global threats and the transnational nature of the industry mean that solutions need to be global and thus require urgent and continuing attention by the ICAO and the full cooperation of all contracting States.

Since then, the world community has made remarkable progress, through global cooperation, in containing acts of terrorism against civil aviation. Our determination to maintain the highest level of aviation security was evident from the opening day of the 33rd session of the ICAO Assembly, held just two weeks after the events of 11 September 2001. It initiated immediate action, including the review of existing security standards contained in Annex 17 to the Convention on International Civil Aviation [1]. It also convened a high level, ministerial conference on aviation security in February 2002, with the overall objective of preventing, combating and eradicating terrorism involving civil aviation, restoring public confidence in air travel and promoting the health of the air transport industry.

This historic conference unanimously endorsed an ICAO plan of action for strengthening aviation security, which was later approved by the Council of ICAO. The plan includes a universal security audit programme (USAP) and is complemented by a series of programmes and activities designed to help States comply with the standards and recommended practices (SARPs) contained in Annex 17. One of the programmes involves a diligent assessment of new and emerging threats to aviation security so as to develop an ability to initiate pre-emptive measures relative to airports, aircraft and air traffic control systems.

Another serious threat to civil aviation is the use by terrorists of 'man-portable air defence systems' (MANPADS). ICAO accords the highest priority to this particular threat. The Council of ICAO has considered the threat in its broader context and has insisted that preventive measures be developed in coordination with the appropriate United Nations bodies. In this context, ICAO participated in the work of the United Nations open ended working group to negotiate an international instrument to enable States to identify and trace, in a timely and reliable manner, illicit small arms and light weapons, which was adopted on 8 December 2005.

In light of the latest developments in the United Nations, as well as regional and national initiatives, the 36th Session of the ICAO Assembly, held from 18 to 28 September 2007, adopted Resolution A36-19 on the threat to civil aviation posed by MANPADS [2]. The resolution urges all contracting States to take the necessary measures to exercise strict and effective controls on the import, export, transfer or retransfer as well as storage of MANPADS and to apply the principles defined in the Elements for Export Controls of MANPADS of the Wassenaar Arrangement [3].

The risk of MANPADS cannot be totally eliminated, rather it must be managed. ICAO encourages all contracting States to assess the potential threat to civil aviation operations in their territory posed by MANPADS. Several governments have successfully introduced MANPADS eradication programmes that have been proven to be less costly, but more effective.

The most recent emerging threat was reported by the United Kingdom authorities on 10 August 2006. It concerned an alleged terrorist plot involving liquid explosives to be carried on board civil aircraft flying across the North Atlantic, and it emphasized the vulnerability of the global air transport system. This plot revealed new modus operandi. In response, the ICAO Council convened a special session and directed the aviation security panel to consider the wider implications for aviation security. Since technologies are not currently deployable to detect certain liquid explosives, the Council adopted security control guidelines for screening liquids, aerosols and gels (LAGs), and these were conveyed to States in December 2006, with an effective date of 1 March 2007.

While security is the overriding priority, ICAO was also concerned with mitigating any adverse impact on the travelling public, airlines and airports, including duty free and on-board aircraft sales. A secretariat study group was convened to agree on specifications for tamper evident bags (STEBs), that could be used to transport larger quantities of LAGs purchased at the airport or on board the aircraft. These specifications, including an example of the design of the STEB, were conveyed to States in March 2007 for immediate implementation and thus enabling the manufacture of STEBs. ICAO continued its work on various operational issues, including harmonized global guidelines for inventory control and validation of the secured chain of supply.

ICAO continues to monitor and respond to new and emerging threats. States are required to report acts of unlawful interference to ICAO under several international conventions and Annex 17 — Security. Accurate global data enable ICAO to inform States about trends and encourage States to take preventive action in anticipation of potential new threats.

3. ICAO AVIATION SECURITY PROGRAMME

The ICAO Aviation Security Programme has evolved and expanded over time in cooperation with contracting States and concerned international organizations. With regard to the judicial aspect of the ICAO Aviation Security Programme, there are five aviation security legal instruments:

— Convention on Offences and Certain Other Acts Committed on Board Aircraft, Tokyo, 1963 [4];
— Convention for the Suppression of Unlawful Seizure of Aircraft, The Hague, 1970 [5];
— Convention for the Suppression of Unlawful Acts against the Safety of Civil Aviation, Montreal, 1971 [6];
— Protocol for the Suppression of Unlawful Acts of Violence at Airports Serving International Civil Aviation, Montreal, 1988 [7];
— Convention on the Marking of Plastic Explosives for the Purpose of Detection, Montreal, 1991 [8].

These instruments have become the basis for international law and continue to rank among the most widely accepted multilateral international legal instruments. Laws represent only one aspect of combating acts of unlawful interference and alone are insufficient, but when combined with practical physical measures they offer effective deterrence to criminal acts against civil aviation.

The principal document which provides direction for the establishment of security measures is Annex 17. Because this document sets the standards for international aviation security worldwide, it is constantly evolving and being subjected to scrutiny before undergoing any changes. The implementation of the security standards and recommended practices (SARPs) contained in Annex 17 must be commensurate with the level of threat in order to prevent and eradicate terrorist acts involving civil aviation, and when uniformly and consistently applied, lead to a practical effect on the required security regime. More transparent and focused security standards and enhanced compliance with these standards will ensure that the threat is properly countered.

On 30 November 2005, the Council adopted Amendment 11 to Annex 17. The amendment became applicable on 1 July 2006. In order to assist States with the implementation of the provisions contained in Annex 17, the seventh edition of the Security Manual for Safeguarding Civil Aviation Against Acts of Unlawful Interference (Doc 8973) is being finalized and should be available by the end of this year. It now comprises five volumes, each addressing a specific aviation security concern: Volume I — National

Organization and Administration; Volume II — Training, Selection and Recruitment; Volume III — Airport Design and Organization; Volume IV — Preventive Measures; and Volume V — Crisis Management and Response.

In the field of security of travel documents, Annex 9 — Facilitation established the standard requiring that all States shall issue only machine readable passports (MRPs) by 1 April 2010, and recommends the inclusion of biometrics for the purpose of identity confirmation. This technology can also be used in systems for access control in airports and other environments that require security controls. Action taken by the ICAO on the security of travel documents includes the publication of the sixth edition of Doc 9303, Part 1, Machine Readable Passports (MRPs) which contains specifications for electronic enabled MRPs incorporating biometric identification 'ePassports'; the establishment of the ICAO public key directory (PKD), potentially contributes to an effective anti-terrorism and aviation security measure; and the setting up of the universal implementation of machine readable travel documents (UIMRTD) project.

To enable States to comply with the requirement to issue MRPs by 2010, the ICAO provides technical assistance and technical cooperation services through the UIMRTD project. This component initially focused on assisting States with their plans to establish MRPs. ICAO also provides assistance for upgrading MRPs to ePassports, improving their passport issuance systems, and setting up inspection systems and identity management systems.

With a view to developing national training capabilities, it was decided to locate regional AVSEC training centres (ASTCs) within already established training schools. Accordingly, with the assistance of donor States, centres have been established in Amman, Jordan; Auckland, New Zealand; Brussels, Belgium; Buenos Aires, Argentina; Casablanca, Morocco; Dakar, Senegal; Hong Kong Special Administrative Region of China; Johannesburg, South Africa; Kiev, Ukraine; Kunming, China; Moscow, Russian Federation; Nairobi, Kenya; Penang, Malysia; Port of Spain, Trinidad and Tobago; and Quito, Ecuador.

4. ICAO ACTIONS TO ADDRESS NEW AND EMERGING THREATS

The legal dimension of the security challenge needs close scrutiny. Over time, ICAO has established a universally accepted international legal system so that no safe haven exists for the perpetrators of acts of unlawful interference. However, with new types of threats such as the terrorist acts committed on 11 September 2001, gaps and inadequacies exist in the international aviation legal instruments. First, a secretariat study group was appointed in 2006 to review existing conventions and other air law instruments to determine whether they should be updated to address new and emerging threats to civil aviation such as the use of aircraft as a weapon of destruction or the spread of biological, chemical or nuclear substances.

As we know, the actual perpetrators of 11 September 2001 died on that day. But what about those who planned it, financed it, and recruited and trained the perpetrators? Should their acts also be criminalized under international treaties? And what about those who conspire to engage in a credible threat, which is aborted before it can be executed, such as was the alleged plot in the United Kingdom? The secretariat's study group has reported its findings to the Council, which has directed the establishment of a special subcommittee of the legal committee to begin drafting legal instruments in this respect.

More study is needed with regard to potentially devastating attacks involving bacteriological, chemical or nuclear substances, as well as electronic or computer based attacks on air traffic control networks or aircraft. The legal instruments which aim at the repression of suicide attacks against civil aviation will obviously not be effective against the suicide perpetrators themselves. Serious penalties, therefore, should be imposed on those organizing, instigating, sponsoring or financing such terrorist acts and harbouring terrorists themselves.

5. CONCLUSIONS

All of the measures and activities highlighted are designed to ensure a more secure and efficient global air transport system. Our resolve should be to create a security net which is global in nature and so tight that not one further potential act of unlawful interference can slip through.

It is evident that ICAO and its Council have, over the years, treated the subject of aviation security as a problem of top priority. However, acts of unlawful interference continue to pose a serious threat to the safety and regularity of civil aviation. These acts are not confined to any particular area of the world but impact worldwide, regardless of geographical or political boundaries, social systems or other geopolitical aspects. The Aviation Security Programme designed by ICAO stands on the following indispensable elements: political will of the contracting States, regulation and procedures, technology, human resources and implementation.

Although it is believed that the political will of States and the system of regulations and procedures are adequate at present and that technology has developed to meet the challenging threat posed to civil aviation, the essential element in the entire system of aviation security lies in the effective implementation of the security measures to combat the threat of unlawful acts against civil aviation. Implementation of the security measures must be continuous and consistent worldwide. To ensure such a level of implementation, there is a pressing need for close regional and international cooperation, and for assistance to be provided to those States that need support. We must encourage States to register with the ICAO aviation security point of contact network so that States can communicate effectively during situations of heightened threat or security related emergencies. Global cooperation should be intensified to deal with the magnitude and complexity of new and emerging threats, including attacks on satellite based air navigation systems and hard to detect explosives and nuclear substances.

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STRENGTHENING CONTROL OVER RADIOACTIVE SOURCES

Current status of implementation of the Code of Conduct on the Safety and Security of Radioactive Sources

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Abstract

The non-legally binding Code of Conduct on the Safety and Security of Radioactive Sources (the Code) was endorsed by the General Conference of the IAEA in 2003. Since then, 90 States have made a political commitment to the Code in line with Resolutions GC(47)/RES/7.B and GC(48)/RES/10.D. The supplementary Guidance on the Import and Export of Radioactive Sources (the Guidance) was endorsed by the General Conference in Resolution GC(48)/RES/10.D. To date, 45 States have notified the Director General of their intention to act in a harmonized manner in accordance with the Guidance. The Board of Governors and the General Conference of the IAEA also endorsed a mechanism for a voluntary, periodic exchange of information among States on their implementation of the Code and Guidance. Within the frame of that newly established mechanism, an open ended meeting of technical and legal experts for sharing of information as to States' implementation of the Code and its supplementary Import and Export Guidance was held in June 2007. The discussions and findings were related to the following topics: infrastructure for regulatory control, facilities and services available to the persons authorized to manage radioactive sources, training of staff in the regulatory body, law enforcement agencies and emergency service organizations, experience in establishing a national register of radioactive sources, national strategies for gaining or regaining control over orphan sources, including arrangements for reporting loss of control and to encourage awareness of, and monitoring to detect, orphan sources, approaches to managing sources at the end of their life cycles and experience with implementation of the Code and the Guidance. As highlighted in the Chair report of the meeting, there was widespread international support for the Code and the Import/Export Guidance. However, the implementation of the provisions is not even and depends on the availability of sufficient resources and expertise.

1. INTRODUCTION

Radioactive sources provide great benefit to humanity through their utilization in agriculture, industry, medicine, research and education, and the vast majority are used in well controlled environments. Nonetheless, control has been lost over a small fraction of these sources, resulting in accidents, some of which had serious — even fatal — consequences. Indeed, accidents and incidents involving radioactive sources indicate that the existing regime for the control of sources needs improvement (Fig. 1). Typical reasons for sources becoming vulnerable or orphan are a lack or weakness of regulatory control and physical protection throughout the life cycle as well as a lack of disposal options.

Additionally, today's global security environment requires more determined efforts to properly control radioactive sources. Consequently, the current regimes must be strengthened in order to regain control over sources that are outside of regulatory control (orphan sources), as well as for sources that are vulnerable to loss, misuse, theft or malicious use. Besides improving the existing situation, to ensure the long term sustainability of control over radioactive sources, effective national infrastructures are needed. An effective national infrastructure should include an appropriate legal framework and

FIG. 1. Disused irradiators stored under inappropriate safety and security conditions.

regulatory system as well as technical infrastructure tailored to the current and anticipated extent of radioactive source applications in the country. Appropriate norms and standards at the national and international levels must continue to be developed to ensure the long term sustainability of control over radioactive sources. At the international level, the importance of international undertakings to establish broadly accepted norms and standards for the control of sources cannot be underestimated.

2. INTERNATIONAL UNDERTAKING

The non-legally binding Code of Conduct on the Safety and Security of Radioactive Sources (the Code) [1] was endorsed by the General Conference of the IAEA in 2003. The supplementary Guidance on the Import and Export of Radioactive Sources (the Guidance) [2] was endorsed by the General Conference in Resolution GC(48)/RES/10.D. The objectives of the Code are to:

— Achieve and maintain a high level of safety and security of radioactive sources;
— Prevent unauthorized access or damage to, and loss, theft or other unauthorized transfer of, radioactive sources, so as to reduce the likelihood of accidental harmful exposure to such sources or the malicious use of such sources to cause harm to individuals, society or the environment;
— Mitigate or minimize the radiological consequences of any accident or malicious act involving a radioactive source.

3. CATEGORIZATION OF RADIOACTIVE SOURCES

When establishing standards, norms, regulations and effective technical infrastructure for the control of radioactive sources, a graded approach is needed in order to optimize both the control measures and the resources necessary to establish and maintain those measures. The IAEA Categorization of Radioactive Sources [3] provides a tool for applying such a graded approach (Table 1). This categorization system is based on the concept of ‘dangerous sources’ — which are quantified in terms of ‘D values’, originally derived in the context of emergency preparedness [4, 5]. The D value is the radionuclide specific activity of a source which, if not under control, could cause severe deterministic effects for a range of scenarios that include both external

TABLE 1. RECOMMENDED CATEGORIES FOR SOURCES USED IN COMMON PRACTICES [3]

Category	Practice	Activity ratio A:D
1	RTGs; irradiators; teletherapy; gamma knife	$A^a:D^b > 1000$
2	Gamma radiography; brachytherapy (HDR/MDR)	1000 > A:D > 10
3	Fixed industrial gauges (e.g. level, dredger, conveyor gauges); well logging	10 > A:D > 1
4	Brachytherapy (LDR except eye plaques and perm implants); portable gauges; static eliminators; bone densitometers	1 > A:D > 0.01
5	Brachytherapy (eye plaques and perm implants); XRF; ECD	0.01 > A:D > exempt/D

[a] A: Source activity.
[b] D: Radionuclide specific 'dangerous' activity.

exposure from an unshielded source and internal exposure following dispersal of the source material.

This categorization is used to define those sources which are within the scope of the Code and the Guidance. The Code applies for Category 1, 2 and 3 sources except the paragraphs related to the import and export of sources which apply to Category 1 and 2 sources only. The Guidance applies to Category 1 and 2 sources.

4. STATUS OF IMPLEMENTATION OF THE CODE AND THE GUIDANCE

Since the endorsement of the Code by the IAEA General Conference in 2003, 90 States have written to the Director General of the IAEA, in line with Resolution GC(47)/RES/7.B, about their commitment in working towards following the guidance contained in the Code. Forty-five States have notified the Director General, in line with Resolution GC(48)/RES/10.D, of their intention to act in a harmonized manner in accordance with the Guidance since its endorsement in 2004. In 2006, the Board of Governors and the General Conference of the IAEA also endorsed a mechanism for a voluntary, periodic exchange of information among States on their implementation of the Code and Guidance.

Within the frame of that newly established mechanism, an open ended meeting of technical and legal experts for sharing of information as to States' implementation of the Code and its supplementary Import/Export Guidance was held from 25 to 29 June 2007 at the IAEA headquarters in Vienna. The meeting was attended by 122 experts from 70 Member States of the IAEA, two non-Member States, and observers from the European Commission, the Organization for Security and Co-operation in Europe (OSCE) and the Food and Agriculture Organization (FAO). The objective of that meeting was to promote a wide exchange of information on national implementation of the Code and the Import/Export Guidance. Experts from 53 States presented papers followed by discussions in three country groups. The three country groups met in plenary to discuss the overall findings of the meeting. The key issues related to infrastructure for regulatory control, facilities and services available to the persons authorized to manage radioactive sources, training of staff in the regulatory body, law enforcement agencies and emergency service organizations, experience in establishing a national register of radioactive sources, national strategies for gaining or regaining control over orphan sources, including arrangements for reporting loss of control and to encourage awareness of, and monitoring to detect, orphan sources, approaches to managing sources at the end of their life cycles and experience with implementation of the import and export provisions of the Code and the Guidance.

Based on the presentations and discussion, the following conclusions were reached and summarized in the report of the Chairperson:

— There is widespread international support for the Code and the Import/Export Guidance. States that have not yet made a political commitment to the Code or the Guidance were encouraged to consider doing so. It was noted that a political commitment to the former did not automatically equate to a political commitment to the latter — although it was possible to make a commitment to both documents in a single communication to the Director General;
— The adoption and implementation of the Code by States, and the IAEA's technical cooperation programme have produced significant improvements in the regulatory infrastructure and capability in relation to radioactive sources in many States;
— In relation to the import and export of Category 1 and 2 sources, many States have already provided national points of contact (POCs) to the Secretariat, and this information is available on the IAEA web page dedicated to the Code. It was recognized that this information is of

mutual benefit to both importing States and exporting States, and all States are encouraged to provide their POCs to the Secretariat and to inform it of any future updates or changes to that information;

- The establishment of a national registry of sources is an essential element of the regulatory control process and should be given high priority;
- Orphan sources detected at national borders need to be managed in a safe and secure manner. This area of concern would benefit from further multilateral discussions;
- The importance of sustainability of implementation of all areas of the Code was emphasized. Such sustainability required the development of national expertise within all States, and ongoing international, multilateral and bilateral support. Some participants encouraged the IAEA to monitor ongoing progress in this respect;
- The participants agreed that the meeting achieved the objective of facilitating the exchange of information between States. The self-assessment process involved in the preparation of papers had also been of benefit. Participants appreciated the open nature of the discussions and encouraged the Secretariat to hold similar meetings in the future, perhaps on a triennial basis, subject to availability of funds.

5. CONCLUSION

To date, 90 States have made a political commitment to the non-legally binding Code and 45 States to the Guidance. Those numbers indicate widespread international support for the Code and the Guidance. However, the implementation of the provisions is not even and depends on the availability of sufficient resources and expertise. A further meeting will be held in Vienna in May 2008 to provide a forum for States to share lessons learned in applying the Code's supplementary Guidance on the Import and Export of Radioactive Sources with a view to strengthening its harmonized implementation.

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CUBA'S COMMITMENTS ON SECURITY AND NUCLEAR NON-PROLIFERATION
Experiences of the struggle against illicit nuclear trafficking and the malevolent use of radioactive material

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Abstract

The implementation of legal standards for the proper use of nuclear energy for peaceful purposes has acted as a basic barrier to prevent illicit nuclear trafficking and malevolent use of radioactive materials. The wide dissemination of nuclear techniques has been supported by the commitments assumed by Cuba with international agencies in favour of security and nuclear non-proliferation. After 11 September 2001, Cuba updated its binding and non-binding commitments adopted by the international community as a relevant multilateral platform for nuclear security. The paper shows the domestic experience on the implementation of its commitments and the strengthening of the multi-institutional approach to prevent and combat illicit nuclear trafficking and the malevolent use of radioactive materials. In addition to this, it shows the challenges and pressing strategies to face this issue.

1. INTRODUCTION

The need for safety and security measures to support the peaceful uses of nuclear and other radioactive materials in social and economic development has been recognized for many years. The implementation of legal standards has acted as a basic barrier to prevent illicit nuclear trafficking and the malevolent use of radioactive materials. Another relevant barrier has been the implementation of appropriate technical measures. The present paper shows the Cuban experience on the implementation of its commitments and the strengthening of the multi-institutional approach to prevent and combat illicit nuclear trafficking and the malevolent use of radioactive materials.

2. INTERNATIONAL INSTRUMENTS

After 11 September 2001 and at the request of the United Nations General Secretary, Cuba was one of the first States to join the 12 international instruments in force at that time for the struggle against terrorism. Regarding security and nuclear non-proliferation, Cuba has been paying careful attention to the international discussions of relevance for nuclear security and has updated its binding and non-binding commitments on this matter. At the end of October 2002, it ratified the Treaty for the Prohibition of Nuclear Weapons in Latin America and the Caribbean, and two weeks later adhered to the Treaty on the Non-Proliferation of Nuclear Weapons.

2.1. Topics of relevance at the United Nations level

In conformance with United Nations Security Council Resolution 1373 (2001) requirements, Cuba does not support any financing, planning, preparation or perpetration of terrorist acts. According to Cuban Law No. 93 of December 2001, Law against Acts of Terrorism, such crimes can be subjected to sanctions of imprisonment from 10 to 30 years.

In conformance with United Nations Security Council Resolution 1540 (2004) requirements, Cuba sent its national report[1] to the 1540 Committee on October 2004. A year later, this report was updated.[2] In line with this commitment, it has been enhancing the national infrastructure for preventing and combating illicit nuclear trafficking.

2.2. Topics of relevance at the IAEA level

Cuba's relevant binding and non-binding commitments on security and nuclear non-proliferation are the:

— Convention on Early Notification of a Nuclear Accident;

[1] S/AC.44/2004/(02)/50.

[2] S/AC.44/2004/(02)/50/Add.1.

— Convention on Assistance in the Case of a Nuclear Accident;
— Convention on the Physical Protection of Nuclear Material;
— Safeguards Agreement and Additional Protocol;[3]
— Code of Conduct on the Safety and Security of Radioactive Sources;
— Illicit Trafficking Database Programme.

3. DOMESTIC EXPERIENCES ON THE STRUGGLE AGAINST ILLICIT NUCLEAR TRAFFICKING AND THE MALEVOLENT USE OF RADIOACTIVE MATERIALS

From the beginning of the Cuban nuclear programme, a basis for building up a national infrastructure to cover the new responsibilities acquired in the area of nuclear and radiological safety and security was established. Among the system of regulatory measures to be enforced under the Decree-Law No. 56, For the regulation of the Pacific Use of Nuclear Energy, issued in May 1982, were the State System of Accounting for and Control of Nuclear Materials and the System for Physical Protection of Nuclear and Radioactive Materials. The improvement process of the legal and regulatory framework led to the establishment of its Hierarchical Nuclear Regulatory System having at its highest level the Decree-Law No. 207, For the Use of Nuclear Energy, issued in February 2000 [1].

From the beginning of the 1990s, Cuba has made an important contribution to the prevention of illicit nuclear trafficking and the malevolent use of radioactive materials with a national centralized collection of unused radioactive materials.

In 2002, based on document GOV/2001/50 “Protection against Nuclear Terrorism”, a first phase of a Domestic Nuclear Security Action Plan was defined.

3.1. Main elements of the action plan and outcomes

3.1.1. Strengthening national regulatory infrastructure

In October 2004, at the request of the National Centre for Nuclear Safety (CNSN), the IAEA carried out a Radiation and Security of Sources Infrastructure Appraisal mission to assess the effectiveness of the regulatory

[3] INFCIRC/633 and INFCIRC/633/Add.1.

infrastructure for radiation safety. As a result, an action plan was developed for areas such as:

— *Legislation and regulations:* Based on a wide set of IAEA technical documents, guidelines and recommendations, the regulatory authority worked on the following basic issues:
  - Drafted a regulation which includes the categorization of radiation sources and establishment of security groups for nuclear security of radioactive materials;
  - Put into force a CITMA[4]–MINCEX[5] Joint Resolution for the radiological control of scrap materials [2];
  - Put into force a CITMA regulation "Rule for the safety management of radioactive waste" [3];
  - Drafted an update of the penal code according to Cuba's new commitments.

In accordance with the proposed policy and strategy for the establishment of the regulatory framework, the rules are planned to be revised every five years.

— *Regulatory authority:* CNSN conducts the methodological supervision for the regulation and control at the national level. Methodologies are being prepared for enhancing the regulatory action in a uniform way in the three different regions of Cuba's supervision and control system. The regulatory system holds yearly meetings to debate problems and agreement on common actions;

— *National registry of radiation sources:* CNSN has implemented a database containing the inventory of nuclear materials and radiation sources under its control;

— *Notification/authorization:* Nuclear materials and radioactive sources are controlled by a compulsory notification/authorization process. The whole subject of authorizations has been revised, and changes are being introduced into the newest modified version of the rules for authorizations.

— *Inspection of practices:* A methodology was prepared for establishing a risk based approach for every practice, taking into account the associated

[4] CITMA: Ministry of Science, Technology and Environment.

[5] MINCEX: Ministry for Foreign Trade.

hazards of the sources and other criteria which may lead to an optimized performance regarding the inspection planning;

— *Enforcement policy:* Formal procedures were developed for enforcement actions, including arrangements with other relevant enforcement institutions such as customs authorities for strengthening the border radiological control; the Ministry of Interior with regard to nuclear security enhancement; and the Ministry for Metallurgic Industry with regard to scrap metal.

3.1.2. Strengthening prevention, detection and response capabilities

Strengthening prevention, detection and response capabilities includes the following:

— *Prevention and detection of illicit trafficking or the malevolent use of nuclear and other radioactive materials:* The experience so far applying this control has helped to establish a regulatory strategy for enhancing the control at the borders. Among the actions taken can be mentioned the updating of the radioactive batches codes of the customs database; the training of customs personnel and personnel from other relevant agencies involved in security in radiological subjects; and the enhancement of the technical capabilities for detection at the borders mainly in the trade of scrap materials;

— *State System of Accounting for and Control of Nuclear Materials:* There is an appropriate system implemented that assures Cuba's commitments to nuclear non-proliferation. It has two areas for material balance with a total amount of nuclear material less than one effective kilogram. The domestic control does not exempt any nuclear material, even though the IAEA allows some exemptions;

— *Security of nuclear materials and other radioactive sources:* A national threat assessment was developed. Also, a regulation was drafted which includes the categorization of radiation sources, and defines security levels and security objectives applicable to radioactive materials. The programme of inspection is being improved through the revision of the relevant procedures;

— *Response to threats or malevolent acts with radioactive materials:* In addition to having the capability and the national infrastructure improved for dealing with radiological emergencies, CITMA together with other State authorities, has defined national strategies for detection, recovery and safe management of possible orphan sources; monitoring and controlling radioactive materials at borders; and updating the national and ministerial radiological emergency plans.

3.1.3. Other matters

For the last seven years, CNSN has been holding a yearly regulatory conference for managers of the users of nuclear and other radioactive materials. Two of these conferences included relevant discussion on safety and security nuclear issues. The main topic of the 2002 conference was the national control of radioactive materials, and of the 2006 conference the import/export of nuclear materials and other radioactive materials.

In the last two years, CITMA in cooperation with other organizations, prepared and broadcast through a television educational programme the following courses: 'Radiation and Life' and 'Law and Environment'. They made a great contribution to enhancing public awareness of the safety and security of radioactive materials.

Currently, CNSN is involved in the regional project 'Regulatory Infrastructure for the Safety and Security of Radiation Sources'.

4. CHALLENGES AND PROSPECTS

The regulatory strategy 2007–2010 for the improvement of the system of regulation and control of radiation safety, and control and accountability of nuclear materials has been defined. Several areas encompass activities having an impact on security matters.

The second phase of the domestic nuclear security action plan has been launched. Better outcomes with regard to the capability for detection at borders are expected. New updates of the legislation will take place. Cooperation among institutions will continue and be enhanced. Training of personnel will be strengthened.

Additional assessments with regard to international instruments and binding and non-binding commitments are foreseen.

5. CONCLUSIONS

For years now, Cuba has had a regulatory authority. As a result of its preventive approach and of institutional cooperation, illicit trafficking incidents have not been identified, and there is reason to believe that most probably none took place.

There is strict control over nuclear material and radioactive sources. The corresponding databases are kept updated.

There is an infrastructure for radiological emergencies which takes into account capabilities for possible needs in response to illicit nuclear trafficking and the malevolent use of radioactive materials.

With the implementation of the second phase, higher performance standards are expected.

Although security is a national responsibility issue, Cuba acknowledges the role of the IAEA on this topic as well as multilateral discussions. Cuba has a strong commitment to nuclear security and non-proliferation and is willing to share its expertise with other countries.

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IAEA-CN-154/019

THE THREAT OF ILLICIT TRAFFICKING IN AN UNDER-RESOURCED COUNTRY
The case of Zambia

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Abstract

From July 1995 to January 2005, five cases of attempted illicit trafficking of spent radioactive materials have been reported and investigated in Zambia. In all five cases, monetary gain was the motivation. The paper describes factors contributing to the vulnerability of Zambia to illicit trafficking of nuclear material, including the consequences of an unstable economy, the involvement of international institutions in Government funding policies, inadequate training or remuneration of personnel and inadequate equipment. To raise awareness among policy makers and the public, a six-pronged strategy is suggested.

Zambia is a landlocked country covering a surface area of 752 650 km^2. This represents about 2.5% of the area of Africa. It shares borders with eight neighbouring countries, namely, the Democratic Republic of the Congo, United Republic of Tanzania, Malawi, Mozambique, Zimbabwe, Botswana, Namibia and Angola. The border is porous with a number of illegal crossing/entry points with neighbouring countries and some of them are unstable, as there is internal fighting. The population of Zambia is 11 million and about 80% of the population lives in abject poverty.

Zambia played a major role in the liberation of some countries within the region and this had an impact on its human and financial resources. This was coupled with low copper prices which is the main income earner for the country. Ultimately, the economic situation fell to such a level that the Government sought donor assistance from cooperating partners, the World Bank and the International Monetary Fund (IMF). This led Zambia to being classified as an under resourced country (least developed country) and Government programmes depended heavily on the assistance of a donor community that prescribed conditions to be adhered to, such as privatizing government firms and restructuring the government civil service. This has a major impact on the safety and security of nuclear and other radioactive materials because the priority of Government funding to institutions will be more for those areas that deal with the health of the general public and will pay little attention to other sectors of the economy, such as nuclear science and technology.

The conditions prescribed to the Government, such as privatizing government companies, trade liberalization and restructuring the government civil service as is the case in Zambia, has led to the retrenchment of employees adding great numbers to an already unemployed sector leading to high poverty levels. A recent Norwegian aid report entitled, Deadly Combination; the Role of Southern Governments and the World Bank in the Rise of Hunger, published by Norwegian Church Aid, Church of Sweden, Danish Church Aid and Brot-für-die-Welt on a study of the impact of economic reforms on hunger prone people in Zambia, Malawi and Ethiopia released on 13 October 2007 found that living standards for most Zambians were deteriorating. It further stated that demands by the World Bank and IMF for the privatization of basic public services and trade liberalization had helped worsen the hunger situation in the world. The high poverty level has made a large populace desperate for survival and the population can therefore be used to do anything including trafficking of nuclear or other radioactive materials.

Inadequate training of customs and border security personnel at border crossing points or airports, coupled with a lack of detection equipment at entry points poses a threat from illicit trafficking of nuclear and other radioactive materials. In Zambia, five cases of attempted illicit trafficking of spent radioactive materials have been reported and investigated. In all five cases, it was found that the arrested people were trying to sell the radioactive sources for monetary gain. These cases were reported by police during the period 21 July 1995 to 11 January 2005 and the sources involved were ^{137}Cs and ^{60}Co. Fortunately, these sources did not lead to health hazards or deaths due to the timely action of security agencies and the regulatory authority.

The mandate for radiation sources is within the Radiation Protection Authority while the security aspect falls on different stakeholders, some of which have no technical knowledge about radiation. The stakeholders in this category include customs, clearing and forwarding agents, State security/ defence agencies and the operators. The remunerations for staff working for these agencies, in most cases, are inadequate, hence demoralizing workers who can then easily be corrupted. Such a workforce can pose a threat from illicit trafficking of nuclear and other radioactive materials, and will have to be educated on the dangers of nuclear and other radioactive materials, and on detection equipment.

However, before the advent of the terrorist attacks on 11 September 2001 in the USA, the security of radioactive sources was largely addressed by protecting the sources from unintentional access by inappropriately qualified personnel or theft for financial gain. This assumption has now changed to include the need to prevent access to sources by people deliberately and malevolently seeking to cause radiation exposure or dispersal of radioactive materials.

The Government should develop a strategy to improve the security and safety of nuclear and other radioactive materials by massive awareness campaigns for the general populace which should be sustainable. Such an awareness will be a good way of sensitizing the policy makers and the members of the public about the environmental effects and what steps can be taken to ensure the security and safety of nuclear and other radioactive materials. This will also enable the public to acquire necessary information and knowledge on how to handle such materials.

The Government should therefore establish and operate an effective system to protect radiation sources and radioactive materials from theft and sabotage, and to ensure safety. This can be achieved by:

— Improving the national infrastructure (physical infrastructure, legal framework, technical capacity and mechanisms for notification, checking compliance and undertaking interventions). In this particular aspect, there is a need to form a national nuclear security committee to deal with issues related to nuclear security in the country. Such a committee should include the key stakeholders, for example, the Zambia Police, National Airports Corporation, Office of the President, Zambia Revenue Authority (Customs Division), Fire Brigade, Cabinet Office, Ministry of Justice, Ministry of Defence, Ministry of Health, etc. In establishing the committee, there must be a memorandum of understanding among the stakeholders as to how they will operate. Above all, there must be a law and regulations provided by the Government pertaining to nuclear security. In Zambia, although in draft form, there is a section in the draft regulations dealing with nuclear security issues;
— Increasing financial support to enable the existence of a national infrastructure which will lead to improved security and effective operations of relevant organs. The financial support should be adequate to sustain an infrastructure on nuclear security and owing to difficulties in the economic performance of the country, the Government should also lobby donors for support and sustain such an infrastructure. This would provide logistics for an effective national infrastructure on nuclear security;

— Conducting training courses in preventing, detecting and responding to loss of control, and the detection of illicit trafficking for customs officers, border control and other law enforcement agencies. The Government should strategize training of the stakeholders at a low level and provide the necessary logistics for an effective monitoring of borders and points of entry. This should include acquisition of detection equipment and training materials;
— Availing information to stakeholders and the public to enable them to understand issues related to trafficking of nuclear and other radioactive materials. This can be done through electronic and print media. Currently in Zambia, the Radiation Protection Authority (RPA) does participate at international trade and agricultural shows which take place once a year in Ndola and Lusaka, respectively, where information on radiation protection is disseminated to the general public. This can be extended to include issues related to nuclear security;
— The Government putting in place a security response plan with clear instructions on how to respond to the threat of illicit trafficking of nuclear or other radioactive materials;
— The Government acceding to international conventions or instruments in order to enhance nuclear security and to get international assistance where necessary. It should also collaborate and cooperate with neighbouring countries in intelligence gathering in order to enhance and promote nuclear security.

At the international level, measures should be taken to increase the global levels of protection and security of nuclear materials by the detection of radioactive materials at borders, which is an essential component of an overall control security strategy to ensure that such materials do not fall into the hands of terrorist groups. Shipment of radioactive materials warrants the attention of law enforcement and regulatory agencies to ascertain legality, and to prevent diversion and illicit trafficking.

In conclusion, Zambia will require the assistance of cooperating partners to acquire detection equipment and to enhance the capabilities of the regulatory authority to improve the security of nuclear and other radioactive materials.

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DISCUSSION

SESSION 2: International Instruments and their Implementation — I

J.W. NIEWODNICZAŃSKI (Poland): What is your opinion on the requirement that a recipient of exported nuclear material must have a Safeguards Agreement with the IAEA with an Additional Protocol in force?

C. STOIBER (United States of America): I strongly agree that the implementation of a comprehensive Safeguards Agreement and an Additional Protocol should be a requirement for the export of relevant material and would contribute — even though they are non-proliferation measures — to the effort to combat illicit trafficking.

A. SEMMEL (United States of America): The USA strongly believes that all States should sign, ratify and bring into force their Safeguards Agreements and Additional Protocols. We believe that an Additional Protocol should be a condition of supply for the transfer of important nuclear items because it would enhance confidence in the dissemination of nuclear technology and material. Our efforts to advance this goal in the Nuclear Suppliers Group (NSG) have met with resistance from several countries.

M. COJBASIC (Serbia): (1) Since I have found the Handbook on Nuclear Law extremely useful and informative, I am wondering when the Handbook on Combating Illicit Trafficking is going to appear. I understand that it was in preparation last year. (2) How does one become a member of the Global Initiative to Combat Nuclear Terrorism?

C. STOIBER (United States of America): (1) Volume II of the Handbook on Nuclear Law — elaborating on the various chapters in Volume I and including model texts of laws and examples of laws already adopted — should be published next year. This will be useful to countries drafting their own legislation.

B.H. WEISS (IAEA): The Handbook on Combating Illicit Trafficking, IAEA Nuclear Security Series No. 6, should be out very soon. It is going through the final stages of publishing now.

A. SEMMEL (United States of America): (2) The procedure for becoming a participating member of the Global Initiative is very simple. Send a note or letter to one of the co-chairs — Russian Federation or the USA — indicating interest in membership. You then have to be accepted but that is normally not problematic. Participation involves commitment to accept the Statement of Principles (SOP) and to participate, where possible, in the activities identified in the Global Initiative's plan of action.

T. TANIGUCHI (IAEA): There are two conventions relevant to emergencies — the Convention on Early Notification of a Nuclear Accident and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency — that are not included in the list of instruments in the last presentation. For the moment, these two conventions focus on safety accident events but security events are closely linked as triggering events. Also, the amended CPPNM and the International Convention for the Suppression of Acts of Nuclear Terrorism explicitly include reporting requirements. The important issue is the coordination and consistency of the reporting. The IAEA has expanded the Incident and Emergency Centre (IEC), which covers both safety and security, and we are working on making it even more effective. ITDB inputs are transferred almost automatically to the IEC. We need to consider how national laws and measures can adequately address these issues.

C. STOIBER (United States of America): Both post-Chernobyl Assistance and Notification Conventions are quite relevant to responding to a nuclear terrorist incident. However, since they were drafted in 1986 in contemplation of a nuclear accident — not a malevolent act — their interpretation could be an issue for some parties. I support a broad legal interpretation to include malevolent acts, but the parties might usefully clarify the issue through amendment of the conventions, development of a protocol or making a statement of interpretation. The IAEA could suggest this to the concerned parties.

SESSION 1: International Instruments and their Implementation — II

A.J. AL KHATIBEH (Qatar): Does the Scientists' Redirective Programme include the relocation of these scientists and, if so, how could other countries make use of these scientists for their peaceful programmes?

S. EVANS (United Kingdom): No, it principally seeks to provide alternative sustainable employment opportunities within their own countries; it is not intended to cause a brain drain.

I. KHROKALO (Russian Federation): Facility inspections in the Russian Federation have revealed several cases of radioactive sources imported without the licence required by the Russian Federation's national regulatory body. This contradicts the provisions of the Code of Conduct and also Russian Federation legislation. We found that the International Civil Aviation Organization (ICAO) regulations allow transport of sources without a licence from the importing country. Is the ICAO going to revise its regulations to conform to the Code?

H.M. BIERNACKI (ICAO): Annex 18 to the Convention on Civil Aviation regulates the legal transport of radioactive material and it also has technical instructions. I shall convey your question to the ICAO expert on dangerous goods, who is responsible for Annex 18. You will receive the requested information.

R. PALGAN (Philippines): (1) Why have so few countries (only 45) signed the commitment to implement the non-binding Code of Conduct's supplementary Guidance on the Import and Export of Radioactive Sources? (2) What are the reservations of the countries that did not sign? (3) Does the World Customs Organization have any reservations about it in the light of trade liberalization and globalization? (4) Are we provided with full texts of the papers presented, in particular those on the Code?

V. FRIEDRICH (IAEA): (1) The discrepancy between the number of countries committed to the Code of Conduct and to the Import/Export Guidance is because (a) it was not clear in the IAEA General Conference Resolution whether countries that had already written to the Director General regarding the Code should write again about the Guidance; and (b) many non-exporting countries did not really consider taking such action, believing that it was necessary mainly for the major exporting countries. However, at several regional meetings/missions, it was explained that any country using radioactive sources could become an exporting country, e.g. when it returned disused sources to the country of origin. Currently, the number of countries committed to the Guidance is growing. (2) Some countries have difficulty committing themselves to such non-legally binding instructions within their national legal framework. However, according to our information, some of these countries do implement the provisions of the Code without making a formal commitment. (3) I have no information about any WCO reservations in this regard.

B.H. WEISS (IAEA): (4) The Conference proceedings will include all the papers in full that have been provided to the IAEA and also a record of the ad hoc discussion.

O. GONCALVES (Brazil): I do not feel that the presentations we have heard at the conference so far are addressing international cooperation on concrete nuclear security needs. What/where are the real problems concerning illicit nuclear trafficking. How can we move forward? Why are some countries not cooperating? Is it just a question of money?

S. EVANS (United Kingdom): Progress is being made and considerable work is under way with IAEA Nuclear Security Fund involvement being particularly important. The scale of the problem worldwide is huge but many concrete steps have been taken and improvements made. Although there is a danger of initiative fatigue, we all need to ensure that it remains a high priority for our Governments. The United Kingdom, for one, has increased its budget for nuclear security and is interested in collaborating in new areas that it has not so far addressed.

B.H. WEISS (IAEA): This afternoon's panel on lessons learned will address the questions you have raised.

J.W. NIEWODNICZAŃSKI (Poland): (1) What is the ICAO's position on aircraft passengers travelling with radiopharmaceuticals in their bodies? Should they be allowed on board? (2) What is the ICAO's official position on shooting down a civil aircraft if it is suspected of being used for a terrorist attack?

H.M. BIERNACKI (ICAO): (1) Annex 9 to the Convention on Civil Aviation (Facilitation) does not contain any specific provisions related to passengers travelling after radiodiagnosis or treatment and still having radiopharmaceuticals in their body. However, the ICAO Technical Instructions for the Safe Transport of Radioactive Goods by Air, Part 8, Chapter 1, Provisions for Dangerous Goods Carried by Passengers and Crew, permit persons to travel by air with radiopharmaceuticals in their bodies or with radioisotopic cardiac pacemakers or other devices (including those powered by lithium batteries) implanted for medical reasons. Clearly, if they would be a health hazard to other passengers, they should not board the aircraft. Incidentally, there is a meeting of the Facilitation Panel in March 2008 that you could attend and raise this question for discussion in order to take it further. (2) The ICAO does not have any provision addressing this matter. However, Annex 17 to the Convention on Civil Aviation (Security), Standard 2.1.1, provides that each contracting State shall have as its primary objective the safety of passengers, crew, ground personnel and the general public in all matters related to safeguarding against acts of unlawful interference with civil aviation. It would be up to a State to decide what to do, depending on the threat level. Similarly, ICAO is asked about its position on sky marshals. Again, this is entirely up to the State.

S. ALIYU (Nigeria): My advice to the speaker from Zambia is to come to Nigeria for technical assistance. We can provide fellowships, and assistance with legislation and with prosecution in cases involving illegal possession or trafficking in sources.

R. GUYONNET (France): The speaker from Zambia did not mention developing a design basis threat (DBT) as part of the way forward in detecting illicitly trafficked radioactive material. Usually, a DBT is the first thing to consider before designing or implementing a set of security measures. Does this mean that you do not find it important?

D. MULEYA (Zambia): A DBT is indeed important and should be included. However, we would need assistance in developing one.

INTERNATIONAL INITIATIVES AND NATIONAL EFFORTS TO ESTABLISH CAPABILITIES

(Session 3)

Chairperson

J. FACETTI
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IAEA-CN-154/082

BUILDING ALLIANCES TO COMBAT NUCLEAR SMUGGLING

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Abstract

The Second Line of Defense (SLD) programme cooperates with host countries throughout the world to provide radiation detection systems, including associated communications packages, training and initial maintenance support for land, sea and air international crossing points. These systems have proven their effectiveness. Though there are numerous challenges in providing these systems for operation in a range of cultures and environments, a different set of challenges emerges after installation. These are challenges in ensuring the long term effective operation of the equipment, available trained personnel and the integration of these systems into broader threat reduction efforts. The key to meeting these challenges is building alliances at multiple levels and between multiple players: between SLD and the host government to develop strong sustainability programmes; among different agencies within a country which previously may not have had extensive interactions; regionally among host countries to meet smuggling challenges; between industry and government to improve technical capability; and globally to leverage resources effectively.

1. PROVIDING DETECTION SYSTEMS

The mission of the US Department of Energy's Second Line of Defense (SLD) programme is to strengthen the capabilities of partner countries to deter, detect and interdict illicit trafficking in special nuclear and other radioactive materials at international border crossings, airports, seaports and other points of entry. As a cooperative effort for mitigating the risk of illicit trafficking, SLD strategy involves the search, detection and identification of nuclear and other radioactive materials; the development of response procedures and capabilities; and the deterrence of future trafficking in illicit nuclear and radiological material. SLD complements first line of defence threat reduction efforts, which are primarily focused on the States of the former Soviet Union. The first line of defence ensures that protections are in place to lock down and protect material at the source in civilian and military facilities. The second line of defence serves as a key component in a layered defence system, seeking to stop trafficking in material that may have escaped from these facilities as it is moved across international borders and through the maritime shipping network.

While SLD works at many different types of sites, it always seeks to establish a comprehensive detection and response system. This system involves an initial set of radiation portal monitors installed at a lane through which vehicular or pedestrian traffic moves, a secondary inspection process for further assessment of traffic that has alarmed the monitors, and a central alarm system (CAS) in which alarms are recorded and reviewed and data is archived. A single site may contain one or more CASs, depending on the number of lanes and deployed monitors. In some cases, the CAS at individual sites in a country may be connected to a central site through a national communications system. The communications system, making use of cameras installed with all deployments, allows the CAS operator to see the vehicle or pedestrian that triggered the alarm. It also graphs the gamma and neutron signal, allowing a trained operator to better understand the alarm event, and provides a place to record comments as to how the event was adjudicated.

The suite of equipment provided by the SLD programme includes dual channel polyvinyl toluene (PVT) based vehicle, pedestrian and rail monitors as well as pilot deployments of advanced spectroscopic portals. It also includes portals for non-fixed locations such as straddle carriers and van mounted monitors, as well as a suite of handheld equipment including personal radiation pagers, radioisotope identifiers, radiation survey meters and highly sensitive germanium identifiers. The van mounted monitors are deployed as a mobile detection system inside borders to provide an element of surprise and uncertainty in monitoring illicit trafficking.

These systems have proved to be very effective at detecting small quantities of material. The well known seizure in 2003 at Sadakhlo in Georgia, for example, resulted from a portal monitor alarm.

SLD's two organizational units, the Core and Megaports programmes, have made major strides in carrying out the programme's mission. The SLD Core programme works primarily in the Russian Federation, the former Soviet

Union, and countries in Eastern Europe and the Mediterranean, and has installed over 850 radiation monitoring systems at 150 sites in seven countries. This includes installations at 29 airports, 70 border crossings, 5 post offices, 41 seaports and 5 training academies. Installation work is ongoing in 14 countries. The SLD Megaports initiative focuses on container traffic moving through major ports around the world and has installed over 100 monitoring systems in 11 countries. This includes installations at 13 Megaports with ongoing work at an additional 13.

2. CHALLENGES: SUSTAINABILITY AND COORDINATION

Once the equipment has been deployed, a different set of challenges emerges: how to ensure the long term sustainability of these systems by the host government, how to coordinate these deployments with other related efforts and how to integrate them into a broader global threat reduction effort.

For these deployments to be successful, a host country needs to take 'ownership' of the systems, allocating sufficient resources to ensure the equipment is appropriately operated and maintained, and ensuring that there is a cadre of trained personnel at every site. Given the resource constraints under which many countries on the frontline of illicit trafficking operate, such support may be difficult to provide, in which case no matter how sensitive the detectors might be, they will not be serving their intended purpose. In addition, unless a country develops a coordinated interagency response to significant events, there may be no follow through on actual instances of illicit trafficking, again vitiating the purpose for which these systems have been deployed. A wide range of groups — customs, nuclear detection experts, law enforcement and intelligence officials — who previously may not have had reason to interact extensively, need to work together to make the installed system result in effective interdictions.

More broadly, without cooperation within and across neighbouring countries, interdiction efforts resulting from detections will be less effective, given that the ability to shut down criminal networks and deal with regional threats requires a multi-agency and multi-country approach. And finally, without global cooperation, there is unlikely to be a broad coverage of priority smuggling pathways, as well as an effective risk based approach based on standardized guidance.

3. BUILDING ALLIANCES TO MEET THESE CHALLENGES

The key to solving these major challenges presented by post-deployment sustainability and integration issues is building alliances at multiple levels and with multiple partners. First, SLD and the host country need to work together to develop country specific sustainability plans that assist the host countries in securing the technical, financial and policy commitments to develop and implement a country specific strategy for success.

SLD's approach is to work with the host country to focus on people, processes and equipment, thus promoting and supporting long term system operations by the host country through effective training and maintenance programmes. One new area for SLD is the establishment of assessment/support teams post-deployment, to gather information in order to provide feedback and recommendations for the host countries. In the spirit of building alliances, these teams could include varying representation as appropriate, including, for example, SLD, host country oversight agencies, the IAEA and the European Union.

SLD is also planning to work with other organizations, partner countries and regional organizations to encourage and support the establishment of workshops, web sites, conferences and other mechanisms for exchange of best practices and lessons learned. The programme plans to encourage and support the development of regional training exercises that test monitoring systems and ensure cross-border interoperability. Finally, the programme hopes to encourage countries who are experienced users of the systems to provide strong regional leadership.

When groups work together, not only do the monitoring systems work effectively, other types of efforts to stop illicit trafficking are also improved. Several recent examples of interdictions were the result of cooperation between multiple agencies within a single country as well as among neighbouring countries.

Industry has a key role to play as part of this partnering effort. By working with industry, available detection tools can be improved and expanded in order to meet the challenges presented by smugglers seeking to defeat the systems. Innovative approaches such as mobile vans also offer new opportunities for detection.

Globally, SLD is taking advantage of cooperative mechanisms in place to ensure complementary approaches to assistance. For example, Canada and New Zealand are utilizing SLD as a mechanism to fund work, ensuring equipment compatibility and a unified approach to in-country assistance. The Global Initiative to combat nuclear terrorism offers another mechanism for countries to cooperate on preventing illicit trafficking, as do donor coordination programmes available through the IAEA and the US Departments of State and Energy.

One effective example of this coordination is the Border Monitoring Working Group (BMWG). Since 2005, the SLD programme, the IAEA and the European Commission have used this mechanism to coordinate border security efforts. This approach avoids duplicate installation and training activities, thus maximizing the available resources, and promotes a coordinated approach to sustaining enhancements in border security.

In summary, we will make progress in combating nuclear smuggling only if detection systems are effectively sustained through strong joint maintenance and training efforts; information and experience related to detection systems are appropriately shared to facilitate improved monitoring and deployment approaches; a wide range of groups — customs, nuclear detection experts, law enforcement and intelligence officials — work together to ensure that the installed systems result in effective interdictions; and detection systems are effectively integrated into a host country, regional and global strategy for detecting illicit trafficking.

IAEA-CN-154/066

ROSATOM PRACTICE IN THE PREVENTION OF UNAUTHORIZED HANDLING OF NUCLEAR AND OTHER RADIOACTIVE MATERIALS

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Abstract

It has become an imperative for the global community that all declared radioactive materials be under strict control and in absolute safety in owner States. The Russian Federation realizes the gravity of these threats and supports an integral approach to the planning and execution of activities ensuring nuclear security and to organizing protection against any offence which involves the use of nuclear and other radioactive materials. The paper discusses how Rosatom, with its specific role and its activities, contributes to such an approach.

1. INTRODUCTION

The General Conference of the IAEA in September 2001 unanimously adopted a resolution which regards terrorist acts worldwide as an unprecedented challenge to humankind.

The articles of the United Nations Security Council Resolution 1373 of 2001 [1] and Resolution 1540 of 2004 [2], and the International Convention for the Suppression of Acts of Nuclear Terrorism [3] emphasize the importance of ensuring the safety and security of nuclear facilities and material, and demand that the unauthorized use and illicit transport of nuclear material be prevented.

Yet, we must clearly understand that from the moment of its commencement in various countries, the nuclear industry has produced a large amount of nuclear and other radioactive materials which may be used in different areas of nuclear energy application. Hundreds of tons of nuclear weapons grade materials (HEU and Pu) as well as thousands of tons of radioactive waste have accumulated.

In the last few years, experts more often acknowledge that weapons grade nuclear material (often called ‘direct use material’) is safely guarded and strictly enough accounted for. Yet, the danger of making a ‘dirty bomb’ (i.e. a radiological dispersion device) is quite real.

At the international conference on nuclear security in March 2005 [4], in London, United Kingdom the danger of terrorists getting hold of a radiological dispersion device (rather than nuclear explosives) was duly and clearly noted. The global community must, therefore, be assured that all declared radioactive materials are under strict control and in absolute safety in owner States.

The Russian Federation realizes the gravity of these threats and supports an integral approach to the planning and execution of activities ensuring nuclear security and to organizing protection against any offence including the use of nuclear and other radioactive materials. Such an approach implies creation of an all-State system including all the involved executive bodies of the Russian Federation. The Federal Atomic Energy Agency of the Russian Federation (Rosatom) due to the specific nature of its activities is one of the most important elements of this system.

Minsredmash, the Ministry for Medium Machine Building in the former Soviet Union (predecessor of Minatom, now Rosatom) always regarded the issues of the stable and safe operation of the nuclear complex enterprises over all stages of nuclear industry development (from design of nuclear facilities and operation to final radioactive waste disposal) as most important. After the Chernobyl accident, which clearly showed the magnitude of a large nuclear incident, special attention was focused on issues concerning the prevention of nuclear and technological terrorism. From 1986 to 1988, all enterprises of Russian nuclear complexes and all of their safety and security systems were subjected to a strict safety analysis (including the issues of vulnerability to subversive acts, technological safety and nuclear material transport safety). As a consequence, the whole nuclear safety and security system was drastically revised, specific equipment was modernized and the whole system of nuclear safety related regulatory, legal and technical standards documents was revised to meet up to date requirements.

Based on current regulatory and legislative acts, Rosatom’s activities for ensuring nuclear safety and security, counteracting crime involving nuclear material (including nuclear terrorism and illicit circulation of nuclear material) can be subdivided into two categories:

(1) Ensuring nuclear safety and security at nuclear facilities sites and during transport of nuclear and other radioactive materials;
(2) Technical support of activities of other executive bodies, including security, defence and law enforcement agencies.

The first category includes:

— Physical protection of nuclear material and facilities;
— Nuclear material control and accounting;
— Detection and prevention of illicit handling of nuclear material, including its unauthorized transport;
— Ensuring protection and safety of radioactive material and sources;
— Protection of sensitive information concerning nuclear material, facilities and respective information technologies;
— Creation of a system of measures to respond to emergency situations.

The second category includes:

— Design and production of equipment for the detection of nuclear and other radioactive materials, and delivery of this equipment to the interested executive bodies;
— Expert assessment of various materials, including laboratory testing of samples;
— Inspection of areas, buildings and rooms to detect radioactive contamination;
— Containment control of accidents and incidents involving nuclear and other radioactive materials and sources;
— Gathering, processing and analysis of information which may concern illicit handling of nuclear and other radioactive materials and sources, and reporting the findings to the interested executive bodies and the IAEA;
— Training specialists to operate equipment for the detection, analysis and handling of nuclear and other radioactive materials and sources.

2. FIRST CATEGORY OF ROSATOM'S ACTIVITIES

The first category of Rosatom's activities, namely, counteracting the illicit circulation of nuclear material, is discussed in more detail in the following sections.

2.1. Physical protection of nuclear material and facilities

Firstly, it should be noted that Rosatom has been appointed as a national agency authorized to fulfil the commitments of the Russian Federation in the field of the physical protection of nuclear material. Ensuring physical protection of nuclear material and facilities is a key element under this category of Rosatom's activities. Yet, we must clearly realize that building up effective physical protection and meeting up to date requirements includes multi-aspect actions demanding significant industrial, financial, workforce and other resources.

The main goal in the physical protection area is to reduce the risks of nuclear material losses and to counteract nuclear terrorist acts and other illicit acts involving nuclear material. This goal is being reached through modernizing equipment and physical protection systems at nuclear facilities and through excellence in the performance of security staff. In accordance with a decree of the Government of the Russian Federation, all Rosatom nuclear risk facilities are guarded by forces of the Russian Ministry of the Interior. In addition, nuclear facilities have their own staff guards who assist the Ministry's forces in guarding and in response actions.

Presently, it is clearly acknowledged that effective physical protection and conforming with up to date regulatory requirements, prevents the huge economic costs that are required to mitigate the consequences of possible terrorist attacks.

2.2. Control and accounting of nuclear material

In November 1995, the Federal Law on the Use of Atomic Energy was adopted in the Russian Federation. The law defined the requirements for organizing a national system for physical protection, control and accounting of nuclear material. The law stated the following main principles:

— All nuclear materials are federal property;
— National control and accounting for nuclear material is performed at federal and departmental levels;
— National control and accounting for nuclear material, as well as its physical protection, are fulfilled by a nuclear energy management agency.

Currently, taking into consideration international practice, that permits, in particular, reprocessing of nuclear materials of foreign owners, the law has been amended with regard to the ownership of nuclear power materials of low enrichment. Accordingly, such nuclear materials can be owned by legal entities. However, this does not affect the level at which physical protection, control and accounting requirements are controlled; it remains the same.

The main efforts regarding nuclear material control and accounting are focused on the following:

— Regulatory provision for the national system of nuclear material control and accounting;

— Gathering, processing, analysis and duly reporting of information about the physical inventory and movement of nuclear material;
— Instrument monitoring of the physical inventory and movement of nuclear material;
— Development of an automated information system for national control and accounting of nuclear material;
— Compilation of nuclear materials registers.

2.3. Ensuring protection and safety of radioactive material and sources

National control and accounting for radioactive material, ionizing sources and radioactive waste are fulfilled at federal, regional and departmental levels.

The provision for the protection of radioactive material and sources is fulfilled in accordance with the regulations for physical protection of radioactive material, sources and storages approved by GAN of the Russian Federation (the former State committee for nuclear oversight). The execution and financing of particular activities in this sphere are stipulated by a number of federal and Rosatom target programmes.

2.4. Protection of sensitive information concerning nuclear material, facilities and respective information technologies

Information concerning the physical protection systems of facilities, the location of nuclear material and storages, schedules and routes of nuclear material transport in the Russian Federation is access limited. This information may contain State secret data. Such data are under State protection, consisting of a number of preventive measures, such as setting up closed (limited access) territorial areas, licensing for nuclear material handling activities, selection of experts based on their reliability, honesty, high sense of responsibility (using special tests), etc. These measures also help to ensure nuclear material safety and security.

2.5. Creation of measures system to respond to emergency situations

In order to ensure readiness of response to possible nuclear or radiation emergencies at enterprises and facilities of high radiation (nuclear) risk, and also during transport of radioactive material, a functional subsystem for prevention and liquidation of emergencies was built in Rosatom operating organizations (and facilities).

This subsystem includes:

— A permanent managing department: Nuclear and Radiation Safety Directorate of Rosatom;
— A daily monitoring department: Crisis Situation Centre of Rosatom;
— Permanent alert forces at federal level: five professional emergency technical centres;
— Out of staff search and rescue units of Rosatom enterprises;
— Special search and rescue units:
  - EPRON: Centre for search and rescue technical work underwater;
  - An engineering and technical training centre of robotics.

Rosatom search and rescue units have been specially trained to handle radioactive materials. They have special equipment, including robotic systems and all other necessary equipment.

3. SECOND CATEGORY OF ROSATOM'S ACTIVITIES

The second category of Rosatom activities concerns counteraction against possible terrorist acts.

3.1. Design and production of equipment for detection of nuclear and other radioactive materials

A number of stationary systems, mobile and handheld devices for nuclear material initial detection have been designed to detect in a timely way and suppress any encroachment on intactness and security of nuclear and other radioactive materials, and to detect in a timely way and stop any subversive and terrorist acts threatening the safety and security of nuclear facilities, radiation sources and storages.

Stationary systems for nuclear materials detection can be subdivided, depending on their operation conditions, into railway, highway and walkway portal monitors.

Mobile and handheld monitors are used to detect nuclear material of unknown origin in the field.

3.2. Expert assessment of various materials, including laboratory testing of samples

Special attention is paid to the identification and analysis of detected nuclear and other radioactive materials in order to determine their origin.

In accordance with the provision on the national control and accounting of nuclear material, Rosatom has set up an information analytical centre for measuring the characteristics of nuclear materials and determining their origin in laboratories of the VNIINM Federal Unitary Enterprise.

It should also be noted that this work is very important, considering the organization of an international interaction mechanism for investigating potential unauthorized nuclear material handling incidents and for rendering services of nuclear materials analysis to interested countries. Such work could be done, for instance, in the frame of the IAEA Action Plan, Nuclear Security — Measures to Protect Against Nuclear Terrorism.

3.3. Inspection of areas, buildings and rooms to detect radioactive contamination

At present, Rosatom pays a lot of attention to issues of environmental radiation monitoring. This results in the production of new tools and methods for radiation monitoring that allow faster measurements and a higher precision of laboratory testing.

The automated system for radiation monitoring (ASKRO) is an example of such a tool. This system is designed to provide information and analysis support to operating organizations, Rosatom management and other government bodies of various levels to ensure the radiation safety of personnel, the population and the environment.

ASKRO comprises stationary posts for radiation parameters monitoring, which transmit their readings in an automatic or semi-automatic mode to the information gathering centre for further analysis, processing and delivery to the users. Such posts are located on sites of radiation risk enterprises (enterprise ASKRO) and also in neighbouring settlements and areas (territorial ASKRO). St. Petersburg ASKRO is one of the most developed territorial systems.

3.4. Containment control of accidents and incidents involving nuclear and other radioactive materials and sources

The forces and means of the functional subsystem for the prevention and liquidation of emergencies at Rosatom enterprises and facilities (mentioned previously) are used to respond to potential accidents involving nuclear and radioactive materials and sources (also during their transport).

3.5. Gathering, processing and analysis of information which may concern illicit handling of nuclear material

In accordance with the provision about the Federal Atomic Energy Agency, Rosatom is a communication centre of the Russian Federation on the issue of illicit nuclear material handling incidents, set up on the basis of the articles of the Convention on the Physical Protection of Nuclear Material [5].

Pursuant to the related order issued by Rosatom, all information about illicit nuclear material handling incidents occurring in the Russian Federation is gathered, processed and analysed, and then the finalized material is sent to the interested executive bodies of the Russian Federation and to the IAEA Illicit Trafficking Database (ITDB) [6].

Taking into account the above problems and activities, Rosatom pays special attention to the counterterrorism protection of the new generation of nuclear power technologies. The anthropogenic impact risk of nuclear energy use is a basic concept for building an adequate complex system for the suppression of nuclear terrorism. Such a concept combines nuclear, radiation, fire and environmental risks, as well as the risk of perpetrators' (terrorist) acts. The risk of perpetrators' acts depends in turn on the specificity of the nuclear facility (that is, on its vulnerabilities and effectiveness of technological solutions ensuring its safety and security), as well as on the effectiveness of measures and activities ensuring the physical protection of the facility. The costs of physical protection of the operated nuclear facilities will become considerably less, if their vulnerabilities are reduced (through process protection against unauthorized actions).

The issues concerning the system of measures for counteracting nuclear terrorism must be considered not only during the design and development stages of particular nuclear power facilities, but also throughout the design of the whole nuclear fuel cycle (including mining, production, transport, storage and processing of nuclear and fissile materials, and the resulting products).

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UKRAINIAN EFFORTS TO COMBAT ILLICIT TRAFFICKING OF NUCLEAR AND OTHER RADIOACTIVE MATERIALS

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Abstract

Ukraine possesses an extensive network of nuclear and radiation material, which requires a system for the counteraction of illicit trafficking of nuclear and other radioactive materials. This requirement is provided by a multilevel legislative and regulatory framework of nuclear and radioactive security, specialized systems of accountancy and control, and the interaction of relevant entities in detecting, seizing, recovering and returning lost or uncontrolled materials.

1. INTRODUCTION

Nuclear power engineering and the utilization of nuclear energy constitute an important part of economic activity in Ukraine [1]. The following nuclear and radiation sites are currently in Ukraine (Fig. 1):

- Four nuclear power plants, consisting of 15 units in operation;
- The Chernobyl nuclear power plant in the process of decommissioning and 'shelter' object;
- Two research reactors;
- One subcritical and one critical assembly;
- Uranium mining and reprocessing enterprises;
- Six facilities for radioactive waste management operating in separate regions of the country;
- About 2500 enterprises using radiation sources and about 80 000 sealed radiation sources (excluding medicine sources).

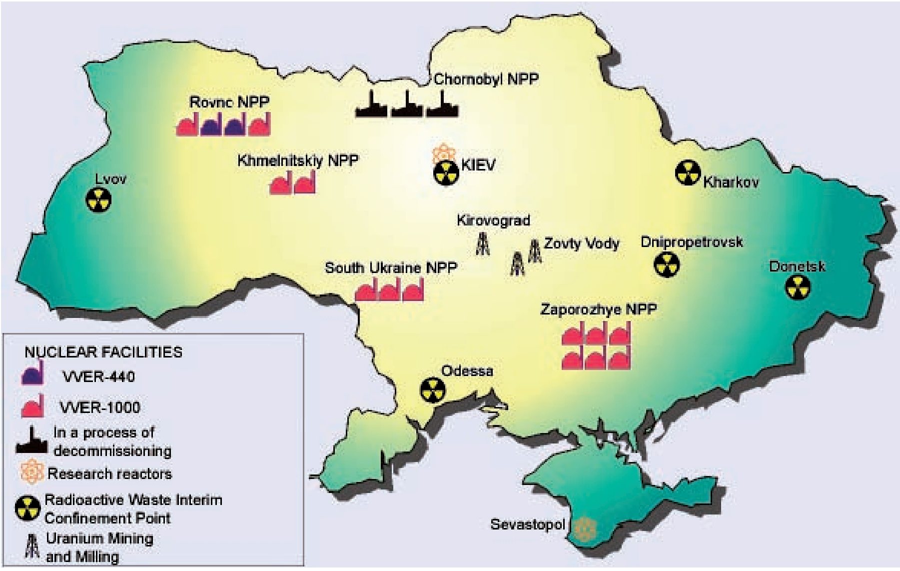

FIG. 1. Nuclear and radiation sites in Ukraine.

At the same time, nuclear materials, radioactive wastes and other radiation sources pose a threat of malicious use, especially in illicit trafficking. The main objectives in the response to illicit trafficking in Ukraine are:

— Minimization of any potential hazard for human health;
— Proper accountancy, control and security of nuclear and other radioactive materials;
— Investigation, proof of offence and legal prosecution of delinquents.

2. LEGISLATIVE AND REGULATORY FRAMEWORK

The legal basis of security of nuclear and other radioactive materials in Ukraine consists of the principal and fundamental law: On Use of Nuclear Energy and Radiation Safety; and specialized laws: On Radioactive Waste Management, On Physical Protection of Nuclear Facilities, Nuclear Materials, Radioactive Wastes and other Radiation Sources; a series of decrees of the Cabinet of Ministers; and regulations, issued by the State Nuclear Regulatory Committee: Rules on the Physical Protection of Nuclear Facilities and Nuclear Materials and Rules on the Security of Nuclear Materials, Radioactive Wastes and other Radiation Sources [2]. One of the fundamental principles of Ukrainian nuclear law is compliance with international requirements and recommendations.

The system of State regulation of safe management of nuclear and other radioactive materials stipulates:

— The establishment of criteria and requirements, determining the conditions for use of nuclear facilities and radiation sources and radioactive waste management;
— Issuing licences and permits to conduct certain activities in the area of nuclear energy utilization;
— State supervision of the observance of requirements and conditions of granted licences by entities using nuclear facilities and radiation sources.

The facts mentioned provide a sufficient basis for the maintenance of security, control and accountancy of nuclear and other radioactive materials. Besides this, questions of counteraction of illicit trafficking could be solved through the laws: On Fighting Terrorism, and On Search and Investigation Activities, and others mentioned in the following discussion.

The main document in the field of illicit trafficking is the Decree of the Cabinet of Ministers “Procedure for interaction of executive authorities and relevant legal persons in the case of radioactive sources detecting in illicit trafficking”. It describes the responsible central and local entities, and their functions in response to illicit trafficking events.

3. SYSTEM APPROACH FOR CONTROLLING AND ACCOUNTING FOR RADIOACTIVE MATERIALS

The extensive network of nuclear and radiological objects in Ukraine requires efficient instruments for accountancy, control and security of nuclear and other radioactive materials. The system approach provides the best results for this purpose — establishing the specialized systems of accountancy and control, and interaction between them.

The first of such systems, the State System for Nuclear Material Accountancy and Control (SSNMAC), was established and since 1994 put in operation by the State Regulatory Body for nuclear and radiation safety in order to ensure compliance with the requirements of the Safeguards Agreement in Ukraine. Its key objectives include [3]:

- Timely detection of losses and unauthorized uses of nuclear material;
- Application of unified nuclear material control methods and its accountancy procedure;
- Inspection verification of accounting data;
- Maintenance of a databank and provision of nuclear material related information both to the IAEA and State authorities.

The competent authority of the system is the State Nuclear Regulatory Committee. The main responsibilities of SSNMAC at State level include:

- Observance of the Safeguards Agreement;
- Issuance of accountancy requirements and rules;
- Surveillance over account keeping at material–balance areas;
- Maintenance of an information system;
- Scientific and methodology support to accountancy organization and maintenance at enterprises.

SSNMAC includes the information system mentioned, performing the acquisition, recording and processing of data on:

- Operating facilities and other places of nuclear material location, their structure and procedures;
- Inventory quantities and characteristics of nuclear material at every facility;
- Transfers of material;
- Inspections and operational information to assess and analyse deprivations, discrepancies between sender and receiver data, and uncounted material quantities.

Basic nuclear material accountancy requirements for facilities and other locations of material:

- Designation of a person responsible for nuclear material accountancy and control, sufficiently authorized to ensure effective functioning of the accountancy system;
- Provision of nuclear material related information to SNRCU;
- Providing access to the State Inspections of Nuclear and Radiation Safety (SNRCU) and IAEA inspectors as appropriate for their activities.

Specialized units responsible for interaction with SSNMAC exist at all Ukrainian nuclear power plants and other nuclear facilities.

In 1998, on the basis of the Ukrainian State Production Enterprise ‘Isotope’ responsible for storage and transport of radiation sources (Fig. 2), a separate subdivision, State Register of Radiation Sources, was established. This subdivision discharged functions of the main registration centre of the national registration accountancy and control system, governed by SNRCU. The register’s objectives are to:

— File data of all radiation sources in electronic form;
— Trace radiation sources from the moment of their appearance in the territory of Ukraine until their removal or transfer to a special enterprise for radioactive waste management (disposal);
— Provide information about radiation sources upon the request of regulatory authorities and State authorities involved in the handling of radiation sources;
— Provide reports to regulatory bodies.

Registration of radiation sources is the implicit requirement for granting a licence for radiation sources management or a permit for their transportation. The databank of the register is the key basis connecting an owner of a detected orphan source, and the acquisition and recovery of missed radiation sources. There is a close interaction between the Register of Radiation Sources and the Radioactive Waste Register.

The State Register for Radioactive Waste was established in 1996 and is governed by the Ministry of Emergencies. The register is an element of the national system for accountancy and inventory of radioactive wastes, and constitutes the successive current registration of set form acts about:

FIG. 2. State Production Enterprise ‘Isotope’: general view of the storage facility (left); depository hall with cells and containers (right).

— Origin;
— Composition;
— Formula;
— Quantity;
— Characteristics;
— Transport;
— Storage and disposal of radioactive wastes.

The Main Data Processing Centre of the State Accountancy System for Radioactive Waste maintains the register. The Centre is based at the State Enterprise 'Radon', responsible for the storage of radioactive wastes in Ukraine. Regional centres, providing information for the Main Centre, are based at six inter-regional specialized enterprises 'Radon', designated for managing radioactive wastes in several regions (see Fig. 1) and at a specialized enterprise in the Chernobyl exclusion zone.

All these systems interact with the State export control system. The key objective of this system is to create reliable mechanisms to counter the spread of weapons of mass destruction. The legal basis for an export control system in Ukraine is represented by the Law On State Control over International Transfers of Military Goods and Dual-Use Goods. The Ukrainian export control system is an inalienable part of the global non-proliferation regime and incorporates the following [4]:

— Legislative and regulatory basis;
— National export control bodies (the Committee for Policy on Export Controls and Military–Technical Cooperation under the President of Ukraine and the State Service of Export Control of Ukraine);
— Other authorities acting in the area of export controls — Ministries of Foreign Affairs, Defence, Economy, Industrial Policy, State Nuclear Regulatory Committee, State Customs Service, Security Service of Ukraine;
— Business entities carrying out international transfers of goods subject to State export controls, including ones that could be used in weapons of mass destruction and delivery means production.

The mainstay of enterprise export control systems are relevant control departments or designated enterprise officials, who ensure compliance with the export control requirements throughout the whole process of international goods transfers.

Export control procedures provide for:

— Registration of business entities intending to carry out international military goods transfers;
— Authorization of business entities to carry out exports/imports of military goods;
— Establishment of export control internal compliance systems within the business entities;
— Issue of licences or conclusions regarding international military and dual-use goods, transfers or negotiations for exporting such goods;
— Customs clearance and customs control over goods pursuant to the Customs Code of Ukraine;
— Receipt or issue of guarantees for goods end use and use location;
— Control of end use of goods by customers and field verifications at declared locations;
— Submittal of business entities of reports on completed transfers and on use of goods on declared purposes;
— Responsibility for violations of established order for international goods transfers, and cover for all the phases of export and import activities.

4. ILLICIT TRAFFICKING PREVENTION

Pursuant to Ukrainian legislation, all nuclear and other radioactive materials are divided into categories according to the established requirements for appropriate levels of physical protection. The observance of these requirements and the trustworthiness verification of persons who get access to work at nuclear facilities, with radiation sources and radioactive wastes, as well as accountancy and control are main steps in the prevention of unlawful taking of nuclear and other radioactive materials.

Unfortunately, while nuclear materials are under stringent control, by far not all other sources and wastes, especially the ‘historical legacy’ of Soviet period industry, including contaminated scrap metal, and materials located at small entities whose owners change, are accounted for and secured appropriately.

One of the main methods of preventing the illicit trafficking of such materials is monitoring possible transport inside the country and border control. Usually, positioned (portal) radiation detection equipment for searching people and goods is applied (Fig. 3). Other measures, such as investigation activities of law enforcement authorities and territory inspections provided by local radiological offices of supervision authorities, gave results as well.

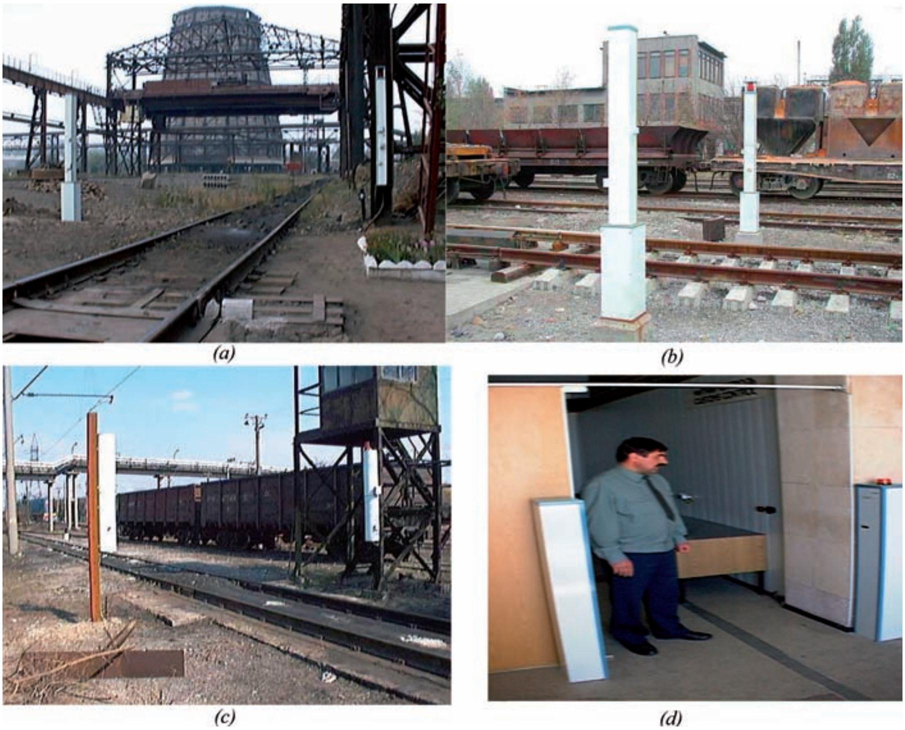

FIG. 3. Monitoring the illegal removal of nuclear and other radioactive materials by positioned equipment: (a) Donetsk metallurgical plant; (b) MMK Istill enterprise; (c) 'Azovstal' industrial complex; (d) border control at Zaporizshya city airport.

In 2006, the eight territorial subdivisions of SNRCU were established. One of their functions is to provide inspections of the radiation situation and detect uncontrolled sources in dependent territories. For this purpose, inspectors received special mobile and handheld equipment, and appropriate training. Previously, these functions were performed completely by regional subdivisions (named 'stations') of the State Sanitary Epidemiological Supervision Service of the Ministry of Health. Now, these stations participate in territory inspections and on-site reviews of detected radioactive materials.

Information related to incidents involving losses or unlawful disposal or discoveries of nuclear and other radioactive materials is immediately provided to SNRCU, designed by the Ukrainian Government as the point of contact with the IAEA Illicit Trafficking Database (ITDB).

Information about all the illicit trafficking incidents in Ukraine is provided by SNRCU to the ITDB as soon as possible. Ukraine joined the ITDB in 1997.

On 31 December 2006, SNRCU established its own database. This database now contains 182 illicit trafficking incidents which occurred in Ukraine; most of them involved radioactive sources (95 incidents), radioactively contaminated scrap metal (81 incidents) and six incidents involved nuclear materials.

The data received by SNRCU from 2000 to 2006 show the trends in the structure of occurrence of incidents in Ukraine (Fig. 4), indicating a decrease of incidents involving nuclear materials to zero [1]. In addition, a downward trend is observed in the occurrence of incidents involving radioactive sources from 17 in 2000 to 12 in 2006. SNRCU recorded an increase in the number of incidents involving radioactively contaminated scrap metal from 8 in 2000 to 16 in 2006.

The majority of illicit trafficking incidents with nuclear material involved depleted uranium (and one of them concerns parts of fresh fuel assembly) as shown in Fig. 5.

An examination of the incidents with radioactive sources shows that most of them involved the radioisotope ^{137}Cs, followed by ^{90}Sr, ^{60}Co, ^{192}Ir, ^{241}Am, ^{226}Ra and ^{239}Pu as seen in Fig. 6.

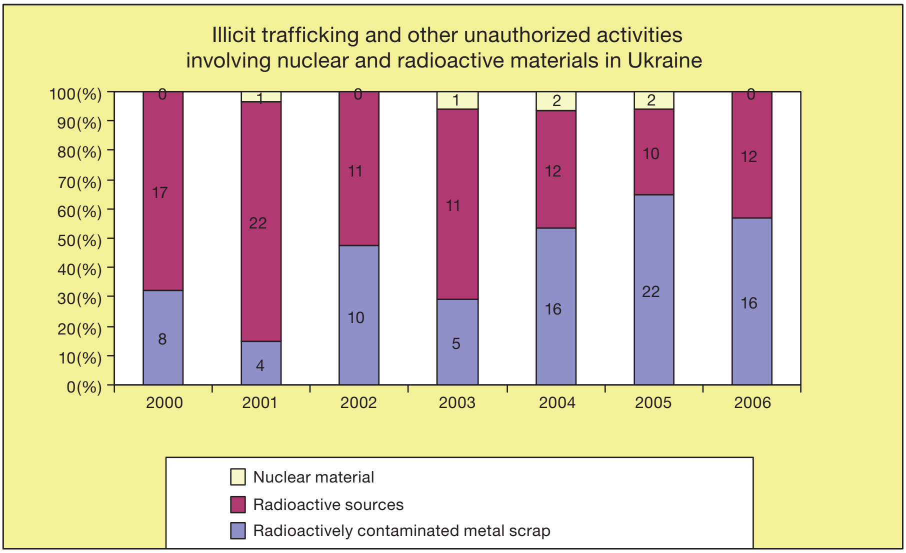

FIG. 4. Trends in structure of illicit trafficking in Ukraine.

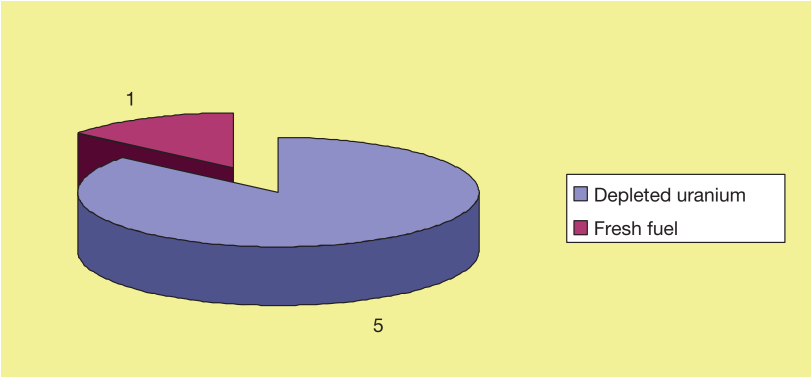

FIG. 5. Illicit trafficking incidents with nuclear material recorded in Ukraine between 2001 and 2006.

Studying the nature of incidents, as indicated in Fig. 7, revealed that more than half of them involved discovery of radioactive material (amidst scrap metal during inspections or as a result of investigation activities of law enforcement authorities). A considerable proportion of the incidents of losses of control of material are as a result of carelessness.

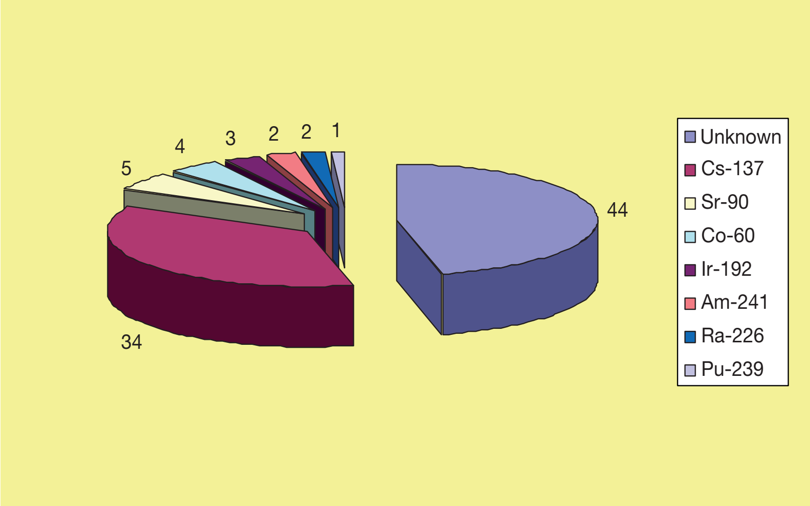

FIG. 6. Illicit trafficking incidents involving radioactive sources from 2000 to 2006.

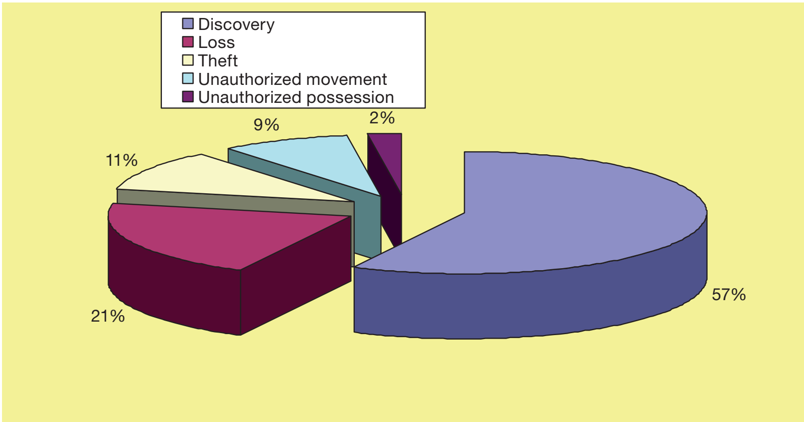

FIG. 7. Nature of incidents.

5. INTERACTION COUNTERS ILLICIT TRAFFICKING

The reasoning from previous sections has been that effective counter-action of illicit trafficking is impossible without the close interaction of concerned entities. Interaction of State authorities responsible for security, accountancy and control of nuclear and other radioactive materials, as well for detecting, seizing, recovering and returning lost or uncontrolled materials, is performed in the framework of State systems, described in Section 3, and the State System of Physical Protection. The latter was established by the Ukrainian Government and was based on recommendations of the IAEA INFCIRC/225 [5].

In the case of radioactive sources detection in illicit trafficking, interaction of the responsible central and local entities is performed accordingly to the Decree of the Cabinet of Ministers mentioned in Section 1. On-site review is carried out by representatives of law enforcement authorities (Ministry of Internal Affairs, Security Service), the Ministry for Emergencies and the State Committee for Borders Control and/or State Customs Control if the event takes place at a border. Measures are coordinated by local executive authorities. When suspicious material from a preliminary inspection is ascertained as a radioactive source (nuclear or other radioactive material), the representatives of the State Inspection of Nuclear and Radiation Safety and State Sanitary Epidemiological Supervision Service are appealed to. The report is given to the local executive authority (Ministry for Emergencies).

The radioactive source shall then be:

— Taken away by an emergency team;
— Placed at a special enterprise for radioactive waste management;
— Stored until an owner is found or a criminal case closed.

The main expert organization in Ukraine on examination of seized nuclear material and other radioactive sources is the Institute for Nuclear Research of the National Academy of Sciences.

6. CONCLUSION

The system approach to security, control and accountancy of nuclear materials, radioactive wastes and radiation sources has made progress possible in the counteraction of illicit trafficking. The potential for removing and smuggling large quantities of weapons grade nuclear material is low in Ukraine but irrespective of this fact, illicit trafficking of nuclear material needs great attention because it may serve as a basis for gradually accumulating nuclear material in quantities sufficient for weapon building. Maintenance of accountancy and security, recovery of lost radioactive materials and detection of uncontrolled radioactive materials continue to be the main challenges.

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SWEDISH–RUSSIAN COOPERATION TO PREVENT AND DETECT TRAFFICKING ON THE KOLA PENINSULA
A work in progress

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Abstract

Since 1996, Sweden has been working on the improvement of nuclear security in the Russian Federation. The first areas of interest for the Swedish Nuclear Power Inspectorate (SKI) were physical protection works. Thus, SKI had established a number of contacts and partnerships in Murmansk and in the Murmansk Region (which in geographical terms is roughly the same as the Kola Peninsula) when, in September 2004, a request came for Swedish cooperation assistance. Russian authorities realized that there were problems involving illicit trafficking of nuclear and radioactive materials. Lengthy negotiations between SKI and Rosatom ensued, involving agreed contracts and status reports which identified several concerns (such as legal inadequacies, and coordination and access difficulties). SKI wishes to remain an active cooperation partner for the Russian Federation in this field. The intention is to find an area where cooperation is the next practical step — possibilities for which include the development of legislation, or structures for cooperation between authorities, or the provision of detection equipment and communication systems.

The issue of combating illicit trafficking is of vital importance to the international community.

Sweden has, since 1996, worked on improving nuclear security in the Russian Federation and particularly in its north-western regions. Physical protection works were the first issues that the Swedish Nuclear Power Inspectorate (SKI) approached in this region and thus physical protection installations have been established at the Ship Repair Yard Nerpa which dismantles nuclear powered submarines and on-board vessels, and at the harbour of Atomflot, the Russian icebreaker fleet in Murmansk. Whenever possible and relevant, SKI has cooperated with other donors and had fruitful cooperation and work sharing arrangements with the United Kingdom and Norway, particularly Atomflot.

By these means, SKI had established a number of contacts and partnerships in Murmansk and in the Murmansk Region (which in geographical terms is roughly the same as the Kola Peninsula), when suddenly a fax arrived in early September 2004. The fax message was short, stating that a number of Russian authorities realized that they were having problems with illicit trafficking of nuclear and radioactive materials and wanted to do something about it. It was understood that, at an initial stage, the Russian partners wanted to establish cooperation with Sweden and not immediately include a larger number of cooperation partners.

A week later, a meeting was held in Murmansk. The meeting took place at the premises of the Murmansk regional government and there were representatives from various Russian authorities and SKI. The atmosphere was tense and this was due to some recent incidents concerning illicit trafficking in the Murmansk Region and because of the terrorist attacks on a school in Beslan, North Ossetia, which had just taken place. As will be remembered, the attacks resulted in the death of hundreds of children and their parents. The cocktail of illicit trafficking and terrorism thus created a murky prospect and menace that everyone in the room was aware of.

The Russian participants in the meeting stated that they lacked sufficient experience in tackling illicit trafficking issues and were interested in Swedish cooperation assistance. However, for the Swedish participants it was also hard to think of something coherent to do as the issue seemed to include much more than, for instance, the delivery of detection equipment. In short, this was an issue which had not been handled before on such a scale. Nevertheless, the meeting came to the conclusion that it was possible to do something by cooperating and combining abilities. Where there was not sufficient knowledge and funding, other parties would be invited to contribute.

Thus, SKI promised the Russian partners to do its best and come back with more concrete ideas. Soon after, a long process of letter exchange with Rosatom was initiated. The letters became longer and longer, and while some issues were clarified, new issues were also added. However, there was no action. After a year's discussions and meetings with various bosses and specialists at Rosatom, the feeling was maturing that it was necessary to move to something tangible. Experts at SKI chose to move ahead by suggesting that a number of issues be analysed by Russian experts and representatives from various authorities. In order to do this, a contract was signed between SKI and a Rosatom affiliated company, Atombesopastnost. The contract listed a number of issues that had to be scrutinized, including:

(1) How big the illicit trafficking problem on the Kola Peninsula actually is, considering that it is a part of the world normally considered to hold the largest amounts of radioactive and nuclear waste. In this, the status with respect to the various facilities that could be leaking materials was also mentioned;
(2) The existing legal base for control and combating had to be assessed;
(3) The efficiency of the cooperation and coordination among the federal and regional authorities operating in the Murmansk Oblast;
(4) Attention was given to the topography and transport infrastructure of the Murmansk Region and how this would be something that illicit traders would consider when they choose trading routes. In short, the contract stipulated that what was needed was an ‘inventory of all the issues and problems’ with respect to illicit trafficking.

In short, a status report was required, or a gathering of all the knowledge and all the unknowns. In January 2007, this first report was finished and discussed by Russian and Swedish experts in Moscow. The report is confidential as concerns its detailed content but it is possible to state that it mentioned a number of issues that are of concern, such as the complicated and also inadequate legal basis at federal and regional levels for combating organized crime. Problems were also identified concerning the coordination among authorities, and a number of civilian facilities were listed as possible origins for smuggling. The report specifically made clear that it was only able to address the civilian sector and thus excluded any scrutiny of the military facilities in the Murmansk Region.

After thus having had a successful reading and discussion of the report, SKI, Rosatom and Atombesopstnost decided to take the knowledge and conclusions one step further, and look at the other side of the coin and devise solutions to the problems that had been identified.

In May 2007, a second contract was signed by SKI and Atombesopastnost, under which Atombesopastnost brings together specialists from all relevant national agencies in order to discuss and agree on ‘solutions regarding the issues identified earlier’, containing problems which need to be puzzled together in order to make a comprehensive combating system against the smuggling of nuclear and radioactive materials. The report is currently being prepared and SKI receives monthly reports on the progress being made. In February 2008, the report will be completed and SKI has assured itself of its relevance for further work in the Russian Federation by making Swedish acceptance of the report dependent on it being signed by all the authorities relevant for the objectives of the report.

At this stage, the parties, SKI, Rosatom and Atombesopastnost will discuss the next steps when the second report has been finalized and scrutinized by the parties in late January 2008. It is intended that the activities continue with respect to four dimensions:

— First of all, to move to an implementation phase of the suggestion in the second report. This also implies that there will be an attempt to engage additional actors to assist with some of the critical issues. This can concern, for instance, legal advice or the provision and delivery of detection equipment and other pieces of infrastructure;
— Moreover, a conference will be convened for Russian and international experts in order to review the state of affairs in the Murmansk Region in relation to physical protection and other security measures at the various facilities. An overview is needed of what has been done and what needs to be done. This is in order to do the preventive work as well as possible;
— In order to be efficient, it is important to learn from others in terms of how a combating system has been set up. Together with experts from the Russian Federation, SKI is currently taking steps to visit a relevant country in Central Europe in order to learn from their experiences;
— With respect to the next and third phase, security issues as well as nuclear safety issues are most efficient where the combating system will be developed. SKI will put much emphasis on the inclusion of communication and information issues. There is a strong conviction that progress in nuclear safety and security are most efficient when there is a widespread knowledge about the activities being carried out. In discussions with Russian counterparts, SKI has often discussed this issue, as Russians are less inclined to focus on the dissemination of information and knowledge to a broader public. Russian colleagues refer to confidentiality as the obstacle. While SKI appreciates this, however, from this point of view, it is possible to inform a lot without negative effects. The responsible citizens may feel reassured and confident, and may even be of help to authorities. On the other hand, the potential traffickers may be deterred when knowing that authorities are working against illicit trafficking. Norms are only created and developed when they reach people.

SKI wishes to remain an active cooperation partner for the Russian Federation in this field. It is thus the intention to find an area where cooperation is the next practical step. This can be with respect to the development of legislation, the development of new and efficient structures for cooperation between authorities or the provision of, for instance, detection equipment and communication systems.

The issue of combating illicit trafficking is of vital importance to the international community. It is important that information, knowledge and experiences be shared. Therefore, it is a privilege and duty for SKI to invite other donors to join together, so that this work can be undertaken together, in a part of the world burdened with the dubious legacy of holding the world's largest amounts of nuclear and radioactive waste.

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THE EXPERIENCE OF IMPLEMENTATION AND IMPROVING IMPORT–EXPORT CONTROL FOR NUCLEAR AND RADIOACTIVE MATERIAL IN MALAYSIA

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Abstract

In Malaysia, nuclear, radioactive and radiation sources are widely used in medicine, industry and research. Malaysia has initiated new or improved measures to combat illicit trafficking of radioactive and nuclear materials through enforcement of a strengthened Act 304 and its regulations. The paper discusses the experience of implementing and improving import and export control for nuclear and radioactive material in Malaysia.

1. INTRODUCTION

Control over the use of radioactive substances began in 1968 when Parliament passed the Radioactive Substances Act 1968. Due to rapid development of atomic energy activities in Malaysia which requires more effective control, inspection and enforcement, the Atomic Energy Licensing Bill was drafted. This Bill was passed by Parliament in April 1984 as the Atomic Energy Licensing Act (Act 304). The Atomic Energy Licensing Board (AELB) was established in 1985 by Act 304.

In line with Section 3 of Act 304, the AELB was placed under the Prime Minister's Department on 1 February 1985. The AELB acted as the enforcement body for the implementation of the Act. However, on 27 October 1990, the AELB was placed under the Ministry of Science, Technology and Innovation (MOSTI).

In Malaysia, nuclear, radioactive and radiation sources are widely used in several sectors:

- Medicine: nuclear medicine, radiotherapy, for diagnostic purposes as well as for medical research;
- Industry: in various industrial applications such as gauging, oil logging, industrial radiography, analyses of mineral and soil samples, quality assurance for electronic components and tracer technique applications;
- Research: in various research and higher learning institutions, such as research in agriculture, medicine and basic nuclear sciences.

Act 304 is the main legal instrument to control nuclear and radioactive material in Malaysia. It is supported by various regulations, such as:

- Radiation Protection (Licensing) Regulations 1986;
- Radiation Protection (Basic Safety Standard) Regulations 1988;
- Radiation Protection (Transportation) Regulations 1989;
- Radiation Protection (Appeal) Regulations 1990.

The AELB also imposes associated radiation protection programmes and conditions of licence which includes the Code of Conduct on the Safety and Security of Radioactive Sources [1].

Based on Act 304, the AELB especially regulates and controls the utilization of nuclear and radioactive and radiation sources for non-medical activities (dealing with and its possession), import and export control, emergency preparedness as well as nuclear safeguards and security. For medical activities, the AELB has delegated the power to the Ministry of Health to enforce Act 304 for medical purposes only.

In Malaysia, licensees must first obtain approval from the AELB before importing or exporting nuclear or radioactive material. Persons wishing to import or export nuclear or radioactive materials into or from Malaysia, are required to first have a licence and subsequently, will be issued a permit to import or export. It is the intent of the AELB that licensees importing nuclear or radioactive materials should not be authorized to do so unless there is a written commitment by the foreign supplier or manufacturer to receive the returned source material at the end or termination of its use. Only authorized licensees may import or export as a supplier or user, by following the procedure below:

- Apply for permit (permit form or e-permit);
- Approval by the AELB;
- Notify the AELB of any change in the arrival, departure, transport or storage;
- Customs clearance;

— Selling declaration (supplier);
— Possession declaration (user);
— Apply approval from the AELB for installation;
— Inspection;
— Apply related IAEA Codes of Conduct [1, 2] as condition of licence;
— In harmony with import–export guidance;
— Confirmation by email or fax with manufacturer or authority abroad.

To ensure that all the activities comply with the regulations, the AELB also performs additional activities, such as inspection, prosecution, seizure and others. In Malaysia, the probability of illicit trafficking may arise from import–export activities, the scrap metal industry, disposal of waste as well as terrorist or sabotage activities.

From the experience of the implementation of import–export control, the AELB has identified and faced some problems:

— Ineffective coordination between relevant national agencies;
— Lack of legislative provisions;
— Inadequately trained staff (knowledge, experience and expertise);
— Information depended only on the initial declaration and based on trust;
— Infrequent effective enforcement.

Below are examples of illegal import or export and possession of radioactive materials in Malaysia:

— 1999: 4 units ^{90}Sr, possession without licence;
— 1999: 1 unit ^{137}Cs, possession without licence;
— 1999: 1 unit ^{109}Cd, possession without licence;
— 2000: 1 unit ^{241}Am, possession without licence.

2. STRENGTHENING NUCLEAR AND RADIOACTIVE SECURITY CONTROL IN MALAYSIA (2006–2010)

In order to strengthen nuclear and radioactive security control, Malaysia has begun to develop and enhance the current prevention, detection and response system. The objectives of this exercise are to:

— Develop and improve capabilities to prevent, detect and establish a response system to combat illegal acts involving nuclear and other radioactive material and associated facilities;

— Ensure that the various relevant agencies share the responsibility for preventing and detecting radioactive and other nuclear material that could be used in malicious acts at borders and other locations;
— Ensure and increase trained personnel in national agencies who may not have or may have only limited scientific education or knowledge in understanding the related threat and of using radiation detection instruments and handling for securing such materials;
— Improve and expand access to technology and user friendly instruments for the detection and identification of radioactive or nuclear material;
— Improve the response and enhance coordination between relevant national agencies.

Further, the AELB is improving import–export control through:

— New legislation;
— Enforcement and procedures;
— Increased coordination:
  - Between relevant national agencies;
  - Between exporter and importer States;
  - Between international authorities, viz. mutual recognition arrangements in particular within the region, such as ASEAN;
— Improved radiation monitoring system nationwide:
  - Installation of portal monitors;
  - Using personal radiation detectors;
  - Using the latest handheld radionuclide identification devices;
— Improved and updated inventory system;
— Developed national disposal and storage facility;
— Increased number of trained personnel;
— Established branch offices;
— Improved emergency preparedness;
— Developed intelligence capacity and capability;
— Increased inspection (regular and spot checks);
— Enhanced regional and international cooperation.

2.1. New system for import and export

Effective March 2007 and in collaboration with the Royal Customs of Malaysia (RCM), an on-line system has replaced the conventional method for applying for permits. There is now a web based e-permit application system that is based on an improved previous requirement. It is now possible to update records on-line at both the AELB and RCM databases.

2.2. National detection system

To further achieve the objectives of regulatory control, beside the RCM, the AELB also works closely with other relevant authorities in Malaysia, especially the Royal Malaysian Police, the Malaysian Port and Airport Authorities, the Malaysian Immigration Department and the National Security Council to coordinate the legal trade of nuclear and radioactive material. The portal detection and response system includes the installation of detectors in more than 30 locations nationwide, identified to be strategic, especially those at borders and points of exit or entry. This is to ensure that all the movement of nuclear and radioactive material is monitored, follows proper procedures and complies with national regulations. The real time portal monitoring system is monitored and centralized at the National Emergency Response Centre located at AELB headquarters. The main purposes of developing the national detection system (Fig. 1) are to:

— Detect any transit and import of nuclear and radioactive materials into the country;
— Be an effective tool for the detection of illicit radioactive materials moving across international borders (covering both road vehicles and persons);
— Control and prevent illicit trafficking at potential entry points into the country: airports, ports and border crossings.

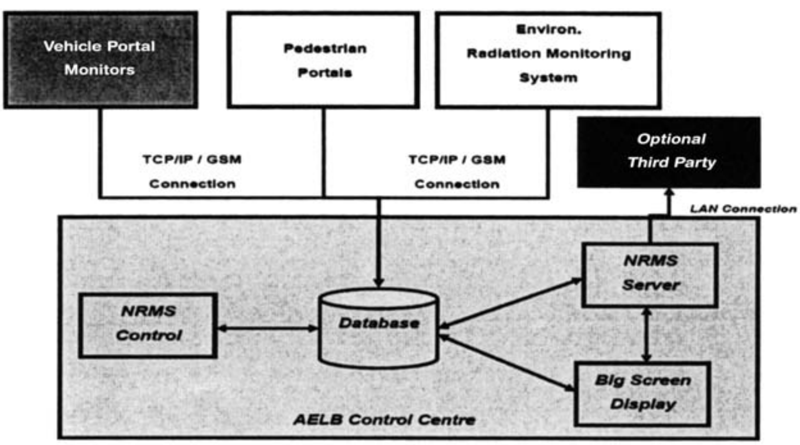

FIG. 1. Schematic diagram of the national detection system.

The detection and response system is designed to detect gamma and neutron sources through portal monitor installations for trucks and persons. This real time monitoring system will be located at borders, airports, ports and the scrap metal industry. The Emergency Response Centre will integrate information for relevant national agencies and to the early warning system (ERMS). The system will be monitored around the clock by at least seven trained personnel. National points of contact have been identified from the relevant national agencies to make the system more effective and efficient.

2.3. Malaysian nuclear monitoring laboratory

In addition to the initiatives above, on 14 July 2007, the Government of Malaysia announced the establishment of essentially, a nuclear safeguards laboratory facility, to be built in Bukit Ibam, Pahang, at a cost of US $26 million and which will further strengthen regulatory control infrastructure. It will also include facilities for environmental sample analyses (national/international), ERMS and training and conference facilities for a planned national nuclear security support centre.

2.4. Megaport initiative

The AELB is also a collaborator and acts as the technical advisor to the RCM in a cooperation programme with the US Department of Energy. At this point in time, discussions are still ongoing and are at the final stages. It is expected that detection equipment will be installed at identified ports and airports.

3. CONCLUSION

To address national and global concerns on the issue, Malaysia has initiated new or improved measures to combat illicit trafficking of radioactive and nuclear materials through the enforcement of a strengthened Act 304 and its regulations. It will have more effective import–export procedures, efficient inspections and spot checks. An effective response will be further implemented by introducing an improved safety and security work culture. The national strategy is primarily expected to be fulfilled by the drafting of a new Act or the repealing of the current set of nuclear laws. This will be augmented by an improved coordination with relevant agencies and the development of a comprehensive inventory of radioactive material. At this present moment, Malaysia has developed a national detection system for nuclear and radioactive material, and has applied the IAEA Codes of Conduct as conditions of licence. Malaysia will be pleased to share its experience to the region and others through the IAEA.

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COMBATING ILLICIT TRAFFICKING IN SLOVAKIA

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Abstract

The paper contains a description of measures used in Slovakia to combat illicit trafficking in nuclear and other radioactive materials, and a short overview of legislation in force and organizations involved in combating illicit trafficking. Though prevention is the most effective measure, suppression measures especially are described as means of how to cope with insufficient protective measures applied in some countries. The paper also describes the international cooperation of the Nuclear Regulatory Authority of the Slovak Republic with the IAEA and the Joint Research Centre in Karlsruhe. Examples of illicit trafficking events recently discovered in Slovakia are given at the end of the paper.

1. INTRODUCTION

Starting with political changes in eastern and central Europe at the beginning of the 1990s, we are facing a new type of crime — smuggling of nuclear and other radioactive materials. Being aware of the serious impact of this new phenomenon on the proliferation and radiation safety risk, the Government of Slovakia undertook measures for combating it. These were mostly concentrated on detection at the State border as well as inside the State and the subsequent safe handling of confiscated material. However, most important is a system of measures preventing removal of material into illegal use.

2. DESCRIPTION OF THE SYSTEM

The main goal of the described system is to allow the safe and effective utilization of nuclear and other radioactive materials under surveillance of responsible State authorities as well as to recover materials that were removed from legal utilization despite the preventive measures.

2.1. Prevention

Prevention is the most effective and the cheapest way of overcoming problems. An important precondition for prevention is the existence of a national (or State) system for controlled utilization of nuclear and other radioactive materials accompanied by the effective physical protection of these materials and facilities involved and supported by sufficient law enforcement.

A State system of accounting for and control of nuclear materials in Slovakia has its origin in the former Czechoslovak Republic. The system was built according to the requirements of IAEA INFCIRC/153 [1]. Since 1 May 2004, Slovakia has been a member State of the European Union and on 1 December 2005, INFCIRC/193 and its Additional Protocol entered into force [2]. The system is based on reports of nuclear material users to the European Union and the Nuclear Regulatory Authority of the Slovak Republic (ÚJD SR). Information on inventory changes reported in this way is subsequently controlled during inspections, and the real status of the inventory is controlled every year by physical inventories. IAEA inspectors independently verify changes in the inventory and the results of the physical inventories.

A similar system is used for other radioactive materials — the regulatory authority in this field is the Ministry of Health but this system is not under international control.

2.2. Physical protection

The physical protection system in Slovak nuclear installations is based on principles applied for the development of advanced physical protection systems used worldwide. Technological systems and nuclear materials, according to their sensitivity, are divided into three categories — the first one being the most sensitive. The first category, technology and material, is located in an inner area, the lower category in a protected and guarded area.

The guarded area of the most sensitive installations is limited by barriers in the form of an isolation zone equipped with two independent detection systems and is monitored by a television system. The protected area is limited by barriers equipped with a single detection system and is monitored by a television system. An inner area is located inside buildings with concrete walls equipped with detection on doors, protected windows and ducts.

Entrances are equipped with locked doors, doors with magnetic locks or turnstiles controlled by card readers. Entrance to the inner area is guarded.

The physical protection system is controlled by sophisticated software. The software runs on PC based computers located in the main control room. Installations' operators operate the system. Entrances are guarded by security guards, which also perform mobile patrol inside the installation. The police create response forces.

2.2.1. Legislation

Act No. 541/2004 Coll. on the peaceful use of nuclear energy regulates the utilization of nuclear material and nuclear energy, and states the requirements on physical protection of nuclear materials and nuclear facilities. The Act fulfils requirements prescribed by European Union legislation.

Regulation No. 51/2006 Coll. on details concerning requirements upon the provision for physical protection describes detailed requirements on physical protection of nuclear materials and nuclear facilities. Regulation No. 57/2006 Coll. on details concerning the requirements on the shipment of radioactive materials describes detailed requirements on physical protection during the transportation of nuclear materials.

Act No. 355/2007 Coll. on the protection, support and development of public health regulates handling with other radioactive materials.

After the first few events of illicit trafficking in Europe, the penal code of Slovakia (Act No. 300/2005 Coll.) has been amended and the illegal possession of nuclear and radioactive material is treated as a crime, and involved persons may be heavily punished.

2.2.2. Suppression

Suppression follows when preventive measures have been broken (either inside the State or in neighbouring countries). Its purpose is to detect illegally owned material and to return it to a legal owner or to dispose of it safely.

After the first few trafficking incidents in the territory of Slovakia, the Government recognized the seriousness of the problem. A group of experts from involved ministries elaborated a system of measures on how to cope with this phenomenon. This system covered the detection of illegally transferred radioactive material at a border or inside the territory of Slovakia, handling and processing of confiscated material, radiation protection of involved persons and improvement of laboratory apparatus of the Ministry of Interior and of the Ministry of Health.

2.2.3. Detection

Based on experience gained during the 1990s, the system was modified several times according to governmental resolutions. The measures were applied in two steps. Within the first step, some portal detectors were installed at the border with Ukraine, and some police and customs officers were equipped with handheld and personal dosimeters. At the second step, portal detectors were installed at all border crossings with Ukraine. Police and customs officers were equipped with handheld and personal dosimeters at all border crossings.

According to the decision of customs authorities, detected material can be returned back to the country of origin or it can be confiscated. In the case of confiscation, a special group of the Civil Defense Authority (CDA) and the Public Health Office (PHO) is called in. Their duty is to carry out basic identification of the material and to apply, together with customs officers, necessary radiation protection measures. The event is reported to the police, who perform an investigation.

Inside State territory, the police mostly confiscate the trafficked material. The police authority usually relies on intelligence information. As in the previous case, a special group of the CDA and the PHO identifies the material and, together with police officers, applies the necessary radiation protection measures.

The laboratories of the Ministry of Health were equipped with apparatus capable of comprehensive analysis of the confiscated material. Due to problems of restricted budget, this intention has still not been adequately performed. For this purpose, services and cooperation with specialized laboratories of some Slovak universities, the IAEA and the Joint Research Centre (JRC) are employed.

3. COOPERATION

Based on the analyses and real experience, it was clear that combating the problem could only be effective if all involved State authorities cooperated. The customs authorities and the police cooperate in the investigation of events, and the CDA and the PHO cooperate with the Nuclear Regulatory Authority of the ÚJD SR (nuclear material) and the Ministry of Health (other radioactive material) on identification of confiscated material.

On the basis of an agreement between the Ministry of Interior (police, civil defence) and the JAVYS joint stock company (JAVYS) specialized in decommissioning, radioactive waste treatment and spent fuel handling, JAVYS carries out transport, storage and preparation of confiscated material in a form suitable for disposal.

There is a special form of cooperation between the Slovak police and police authorities in surrounding States and INTERPOL. This is the most effective way of detecting trafficked material inside the State territory. Indeed, intelligence information from the police allowed, in almost all events, the confiscation of trafficked material in the territory of Slovakia.

A certain form of international cooperation is the participation of Slovakia in the IAEA's programmes in this field, mainly by contributing to the IAEA's Illicit Trafficking Database of nuclear and other radioactive materials (ITDB) (the ÚJD SR is the point of contact) and the participation in the European Union PECO project.

In 2001, a contract between the JRC in Karlsruhe and the ÚJD SR was signed by the chairman of the ÚJD SR. The main goals of the PECO project are to supplement the ITU seized nuclear materials database, to train the country's staff in combating illicit trafficking in nuclear and radioactive materials, and to help specialized laboratories with the analysis of seized nuclear materials.

Within the frame of the PECO project, experts from Slovakia participated in training courses and workshops on combating illicit trafficking of nuclear and radioactive materials, and the JRC supplied special measuring equipment to PHO and special software to the reference laboratory. In 2004 and 2007, the ÚJD SR organized a demonstration exercise on the seizure of nuclear and radioactive material. Since 2005, experts from Slovakia have regularly participated in the International Technical Working Group on Nuclear Smuggling annual meetings.

4. ILLICIT TRAFFICKING EVENTS

Table 1 shows illicit trafficking events registered in Slovakia from 2003. The majority of the events are due to scrap metal contaminated with ^{60}Co or ^{137}Cs. Other events are due to sealed sources, smoke detectors and nuclear materials.

Table 2 shows illicit trafficking events including nuclear material.

5. CONCLUSION

Illicit trafficking in nuclear and other radioactive materials is an international crime and, as such, can only be defeated with the cooperation of the whole international community. Slovakia actively takes part in the international combating of illicit trafficking in nuclear and radioactive materials.

TABLE 1. ILLICIT TRAFFICKING EVENTS IN SLOVAKIA FROM 2003

Year	No. of events	No. of events including nuclear material
2003	11	0
2004	15	0
2005	17	0
2006	24	3
2007 (until end of September)	14	1

TABLE 2. ILLICIT TRAFFICKING EVENTS INCLUDING NUCLEAR MATERIALS IN SLOVAKIA

Year	Material description	Amount (kg)
1993	Yellow cake	2.5
1993	Fuel pellets, enrichment 3%	0.86
1994	Fuel pellets, enrichment 3%	0.92
1995	Natural uranium	18
1997	Fuel pellets, enrichment 3%	2.36
1997	Uranyl nitrate	5.33
1999	Depleted uranium	28
2006	Uranium compounds	0.05
2006	Uranium compounds	5.28
2006	Depleted uranium	11.6 — stolen
2007	^{232}Th, ^{238}U, bulk material	unknown

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THE ROLE OF SCIENTIFIC INSTITUTIONS IN COMBATING ILLICIT TRAFFICKING OF RADIOACTIVE AND NUCLEAR MATERIALS IN AZERBAIJAN

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Abstract

Azerbaijan has no nuclear facilities or nuclear materials. Its nuclear activities are limited to typical uses in the oil industry, medicine, agriculture and scientific research. However, Azerbaijan has a special geographical location in terms of land and sea borders with countries having nuclear technology, nuclear weapons, nuclear reactors and nuclear materials. This means that nuclear related technology, equipment and materials can be transported both illegally and legally through Azerbaijan's borders.

In the face of emerging nuclear terrorism threats, the development and enforcement of an effective national system for the detection, categorization and response to cases of illicit trafficking and criminal use of radioactive, nuclear and nuclear related materials and equipment are important issues for developing–transit countries, such as Azerbaijan, with underdeveloped radiation control systems.

The improvement of the control system for the detection, categorization and response measures to cases involving radioactive and nuclear materials was possible mainly via international cooperation programmes. The Government of Azerbaijan considers this as a more effective route. Taking this fact into account, the Azerbaijan Government is enhancing a system for the detection of radioactive materials at border checkpoints.

As a result of governmental efforts using international cooperation, technical cooperation projects (2003–2006) between Azerbaijan and the IAEA, automated stationary radiation control systems were established at several customs checkpoints.

Enforcement of control and transit requirements pertaining to radioactive and nuclear related items, and prevention of smuggling require awareness and specialized knowledge on the part of customs and border guard officials, and other related enforcement structures. In such a case, the role of scientific institutions is extremely important. Scientific institutions can provide training and retraining to frontline inspectors in using radiation detection equipment. Such training and retraining have to be conducted using international experience and skills on a permanent basis and, therefore, in order to have sustainability it is necessary to have experienced local specialists on these issues. These specialists have to be trained and retrained — 'train the trainers'. In addition, an effective enforcement approach concerning combating illicit trafficking in radioactive and nuclear materials should promote awareness and ensure access to technical expertise.

Although Azerbaijan itself has no nuclear installations or materials, most of Azerbaijan's bordering countries (both land and sea) have nuclear installations or material. Thus, this strategic geographical location within the Caucasus makes Azerbaijan a possible transit corridor for both legal and illicit trafficking of nuclear material and equipment. In the current political climate of an emerging nuclear terrorist threat, the development of a national plan for the detection, categorization and response to incidents of illicit trafficking and criminal use of nuclear and radioactive materials is vitally important. The controls currently in place are considered to be underdeveloped. The best and most effective way for improving and strengthening these controls is via international cooperation programmes.

The Azerbaijan Government and the IAEA entered into international cooperation in which the first phase (2003–2004) established automated stationary radiation control systems at the Astara automobile cargo border checkpoint and the Bara seaport cargo customs checkpoint. The second phase of this cooperation (2005–2006) aimed to further increase efficiency and control over both legal and illicit transports of radioactive and nuclear materials. To do this, automated stationary radiation control systems have been established at two further checkpoints, Mazimchay (Balakan Custom House) and Sinig Korpu (Tovuz Custom House). Cooperation with the Second Line of Defense (SLD) programme of the US Department of Energy (DOE) provides fixed and handheld equipment, related communications tools, and training for personnel to enhance sustainability in equipment use and interdiction procedures at borders and crossing points.

Enforcement of control on legal transports of nuclear or radioactive material and detection of illicit transports of these materials require specialized training of customs, border guard officials and other related enforcement agencies. Such training and retraining need to be conducted on a permanent basis; therefore, local specialists with the relevant knowledge are required. In Azerbaijan, radioactive and nuclear expertise exists in the environment of a scientific research institute. The institute with the relevant expertise is the Institute of Radiation Problems of the Azerbaijan National Academy of

Sciences. They have already worked in the field of non-proliferation, and have technical skills and experience with the issue of illicit trafficking of radioactive and nuclear materials. Since 2003, the institute's specialists have conducted some training courses with inspectors from both the Border Guard Service and the State Customs Committee for the detection of radioactive and nuclear material. The institute's specialists together with experts from the USDOE have conducted a number of commodity identification training courses for customs and border guard officers where detection of radioactive and nuclear material were part of the training. Similar training was also done in collaboration with specialists from the IAEA. It is expected that such activities will be continued and expanded within the framework of the European Union TACIS Multicountry Project. This project will enter into force by the end of this year. The beneficiary of this project is the National Academy of Sciences. The Institute of Radiation Problems is the end user of the project.

A specialized Nuclear Security and Radioactive Safety Centre has been established at the institute to enhance the efforts of providing technical support to enforcement agencies on combating illicit trafficking. The main purpose of this centre will be to provide information, education and technical support to regulatory and enforcement agencies on the reliable detection of nuclear and radioactive materials that could be seized at the national border or within the State. This centre is involved directly when responding to incidents of illicit trafficking or criminal use of nuclear and radioactive materials.

Strengthening the non-proliferation regime and counteracting the nuclear and radiation terrorism threat is a global task. It is necessary to note that all instituions taking part in the achievement of this goal should combine their efforts. Scientific institutions can provide technical support, training and in depth analysis expertise. Training events must be conducted on a permanent basis. Another area for involving scientific institutions could be calibration, maintenance and repairing both fixed radiation detection portals and handheld equipment. This is a very important issue especially from the sustainability viewpoint.

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THE PROBLEM OF ILLICIT NUCLEAR TRAFFICKING AND SOME SOLUTIONS IN KAZAKHSTAN*

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Preventing and combating the illicit nuclear trafficking problem is very important in the region of central Asia. In the Republic of Kazakhstan, it may be connected with its geographical and strategic location, and with the presence of the advanced atomic industrial and research complexes in the country.

The given facts allow one to speak about the necessity of creating qualified radiation control at the State borders and a system of combating illicit nuclear trafficking. To solve such tasks, the Government of Kazakhstan is creating the appropriate legislative basis and a State system of nuclear security regulation.

Currently, Kazakhstan has the legislative basis in the considered area, which includes laws on atomic energy use, radiation safety, licensing, export control and the customs code. Kazakhstan joined the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) and signed an Agreement between Kazakhstan and the IAEA for the Application of Safeguards in Connection with the NPT. In addition, the Republic joined the Convention on the Physical Protection of Nuclear Material, signed the Convention on Nuclear Safety, the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management.

According to national legislation, the Kazakhstan Atomic Energy Committee (KAEC) is a central State body in the field of regulation of atomic energy use. The following State bodies also participate in the considered area:

— Ministry of Internal Affairs;
— Committee of National Security;

* The full paper was not available for publication. The synopsis appears in its place.

— Border Service;
— Committee of Customs Control of the Ministry of Finances;
— Ministry of Extraordinary Situations;
— Ministry of Energy and Mineral Resources;
— Ministry of Industry and Trade;
— Ministry of Health;
— Ministry of Environmental Protection.

For interaction of the listed State bodies, KAEC presented the following proposals to the Government of Kazakhstan to:

— Determine measures for upgrading customs points equipment for the detection of radioactive materials and training of experts of the Committee of Customs Control in educational institutions of Kazakhstan, in the Customs Academy of the Russian Federation and in international centres under IAEA technical cooperation projects;
— Ensure informing KAEC about all revealed facts of the non-authorized movement through State borders of nuclear and radioactive materials, and cargo with radioactive background exceeding naturally occurring radioactive material (NORM);
— Strengthen departments of regional radiological control, to conduct additional training of their staff and to provide special radiometric equipment.

For implementation of these proposals, the following work was done.

Top managers of the Customs Committee took part in the international coordination meeting on problems of illicit nuclear trafficking organized by the IAEA in April 2001. Five experts from the Customs Committee and Committee of National Security received training in IAEA educational centres. With the financial support of the IAEA and Swedish Nuclear Inspectorate, a number of national and regional workshops on the specified problem were conducted in Almaty, Kazakhstan. Representatives of the Ministry of Health and hospitals regularly received training under the IAEA technical cooperation programme. For improvement of the interaction between State bodies, the Republican Service for Radiation Protection was created by a decision of the Government of Kazakhstan. The organization and management of this service is assigned to KAEC.

The stationary complex Yantar-2U at the customs checkpoint Kordai received by the Customs Committee from the IAEA, has now entered into operation. The work on re-equipment of other customs points is ongoing, a large part of which is supported by the US Department of Energy under its

Second Line of Defense programme. The Institute of Nuclear Physics is involved in work within the framework of implementing the programme of the Second Line of Defense in Kazakhstan, on the basis of which centres on expert training in dosimetry control and in physical protection of nuclear installations and nuclear materials are organized. In addition, the Kazakh company SOLO Ltd, which produces equipment for dosimetry control and radiation monitoring, and the JSC National Centre of Expertise and Standards for metrological examination of equipment are taking part in the programme.

Illicit nuclear trafficking can be accompanied with a radiation accident. For the purposes of coordinating response actions for radiation accidents, KAEC together with interested State bodies developed a draft of a State plan for emergency response. Training of Kazakh experts under IAEA technical cooperation programmes is being continued.

Thus, the coordination of measures on the organization of effective customs control of nuclear and radioactive materials, strengthening of dosimetry control from the Ministry of Health and special measures of law enforcement and other State bodies on revealing, prevention and suppression of the facts of illicit nuclear trafficking, training of staff involved in this activity, using special national institutions, is the way to solving the illicit trafficking problem.

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POLAND'S EXPERIENCE IN BORDER MONITORING

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Abstract

Protecting the Polish border against illicit trafficking is an essential element of the national radiation and nuclear security system. To confront this threat, all crossing points at the Polish border have been equipped with sensitive gamma ray monitoring portals which are now gradually being replaced by gamma ray and neutron meters. The Polish legal system is in accordance with all international conventions and European Union standards. Moreover, internal agreements between the regulatory body and other services should prevent fractioning of the responsibilities. When Poland enters the European Union Schengen system, stationary monitors at the internal European Union border will be gradually dismantled and the border guard patrols within the border zone, in addition to the portable instruments carried by the officers, will use radiation meters in their mobile laboratories.

1. INTRODUCTION

The national nuclear and radiation security system of any country has two objectives: securing radioactive and nuclear materials used, stored, deposited or transported within the country, and protecting against illicit shipments to the territory of the country from abroad. The first component relies on licensing and control of any justified activity with radioactive and nuclear materials, performed by reliable and authorized personnel, and the second on the physical protection, control and accounting (including inventory) of these materials. Combating illicit trafficking of radiation sources and nuclear materials across the border relies not only on the measuring equipment installed at border crossing points and radiometers applied by well trained border guard officers, but also on adequate legal and organizational structures. Polish national law in this area takes into account respective international conventions and treaties to which Poland is a party, obligations and procedures originating from regulations of the European Union, and the distribution of responsibilities and duties among central and local governments as defined in the Polish constitution and parliamentary acts. The Polish legal system determines the principles of the licensing of all justified activities involving nuclear materials and radiation sources, and of the control of such activities, thus also of all shipments, including transboundary shipments requiring special permits, as well as penalties for those who violate these regulations. It defines competent authorities for issuing the licences and permits, and is responsible for the design, installation, maintenance and operation of the monitoring facilities at the border checkpoints and other instrumentation used by the border guard officers. Border guard officers that control the transport of goods and persons across the Polish border have to undergo appropriate training and perform their duties following well defined courses of action and procedures, that also involve other services which assist them in the identification, analysis and securing or safe deposition of the goods confiscated if the shipment violates regulations.

2. LAW

According to Polish law, all problems of nuclear safety and security are treated together with radiation protection, including radiological monitoring of the environment, response to a radiological emergency, etc. Thanks to such a solution in Poland, there is not only a joint legal approach to all aspects of radiation protection and nuclear safety, but also State control in that area is executed by one governmental regulatory authority — the National Atomic Energy Agency (NAEA). The fundamental legal national act is the Parliamentary Bill on Atomic Law of 29 November 2000, as amended, and based on that act, regulations of the Council of Ministers. The Atomic Law states that import and export into and from Poland, as well as transit through its territory, of nuclear materials, radioactive sources and equipment containing such sources, including radioactive waste and spent nuclear fuel, have to be well documented and performed by operators licensed for such shipments, and that they require a special permit issued by the president of the NAEA. The terms on which such goods are imported, exported or transmitted, the way of notifying the NAEA president, his premises for granting the corresponding permits, procedures for applying such permits and standard forms of the documents for such procedures should be established by the Council of

Ministers. This was done through the regulation of the Council of Ministers of 27 April 2004, replacing the former document of 5 November 2002. Fulfilling another requirement of the Atomic Law, the Minister of Home Affairs established:

> "the list of border crossings through which nuclear materials, radioactive sources, equipment containing such sources, radioactive waste and spent nuclear fuel can be imported into the territory of Poland and exported from that territory, to ensure the control of compliance of the reported shipment with its actual content and to ensure the protection of workers and members of the public against ionizing radiation."

Recently, a draft of the amendment to the atomic law in connection with directive 2006/117/EURATOM (on transboundary shipment of radioactive waste and spent nuclear fuel) was approved by the Council of Ministers and transmitted to the Parliament, so the respective procedures could enter into force in December 2008, as required by that directive.

Other legal regulations on radiation control at the Polish border are the two parliamentary bills: the Act on Border Guard (of 12 October 1990 with later Amendments), according to which the border guard officers are obliged to control, and if undocumented — to deny entry to Poland of radioactive and nuclear materials through the border checkpoints, and the Act on Customs Service (of 24 July 1999 with later Amendments) which gives the customs officers the right to control, stop or deny entry to the European Union of radioactive and nuclear materials through the European Union border checkpoints. The president of the NAEA signed special agreements with the chief commander of the border guard (amended on 19 August 2005), with the head of the main office of customs (on 7 January 1998) and with the State Protection Office (now the Internal Security Agency) on 24 March 1994. These agreements regulate, among other things, questions of training of border guard personnel, procedures to be used at the border checkpoints, assistance of the NAEA in identifying, evaluating and collecting detected suspicious and undocumented items, and in advising on measuring devices to be installed at the checkpoints or used as personnel equipment by border guard officers. According to the Atomic Law, the president of the NAEA "shall receive the information on domestic radiation emergencies ... and shall provide immediate assistance in the assessment of the radiation hazard magnitude, and shall advise on the elimination of the threat and of the emergency consequences". Further:

> "The President of the NAEA in performing the tasks arising from the international system of the notification of radiation emergencies in the

areas of early notification of a nuclear accident, assistance in the event of a nuclear accident or radiation emergency, physical protection of nuclear materials and illicit trade of such materials, as well as fulfilling the obligations of the Republic of Poland under bilateral international agreements, shall establish national contact points."

The duties of such a contact point are fulfilled at the NAEA by the Radiation Emergency Centre. This unit operates around the clock and provides consultations to the border checkpoint personnel and, if needed, arranges identification of intercepted items at the border or their transport for further analyses and safe deposition at the national radioactive waste depository.

3. FACILITIES

Poland borders the Russian Federation (210 km long border), Lithuania (103 km), Belarus (418 km), Ukraine (535 km), Slovakia (541 km), the Czech Republic (790 km) and Germany (467 km); the States created after 1990 as new political structures replacing the former Soviet Union, Czechoslovakia and East Germany. Of this 3500 km long border, the border with the Russian Federation, Belarus and Ukraine, which adds up to 1163 km, is the external border of the European Union (the 440 km long Baltic Sea shore line should be treated as such as well). In addition to the land border, eight Polish airports serve international airlines and several harbours on the Baltic Sea service cargo and passenger boats. The border checkpoints for roads and railways (for vehicles and pedestrians), and at airports and harbours are equipped with stationary radiation monitoring portals, operated and maintained by border guards. The cost of their installation is covered by the local municipalities. There are more than 215 such monitoring portals, sensitive enough to detect low activities of gamma ray sources. The monitors which have been used in the past few years, type UK-1M — for road and railway checkpoints — and type UKO-1M — for pedestrian checkpoints — contain two 6.4 cm × 6.4 cm NaI/Tl crystals and can detect a dose rate starting from less than 0.02 μGy/h, which means that a ^{137}Cs source with an activity of 125 μCi may be detected when moving up to 30 km/h at a distance of 3–4 m from the detector. These monitors are being gradually upgraded and equipped with neutron detectors. The monitors of the PM-5000 series, equipped with high volume (4.5–8.5 L) plastic scintillators and more than 3 L of ^{3}He proportional neutron counters, can detect, depending on the configuration, as little as 3 μCi of radioactive ^{137}Cs sources and 10 g of ^{235}U (or <1 g of ^{239}Pu) nuclear materials, when moving 1.5 m from the detectors not faster than 5 km/h. Other monitors of the VM250AGN series also measure gamma rays and neutrons, however, their sensitivity is slightly lower than that of the previous devices. When elevated radiation is observed and the programmed alarm threshold is exceeded (usually equal to double the natural background level), optical and acoustic signals are activated and the relevant data are printed. Further examination of the transported cargo or hand luggage has to be performed using a portable instrument. In addition to the stationary monitors, the border guards use portable dosimeters and gamma ray spectrometers of various designs which are applied not only at border checkpoints but also within the border zone. Portable instruments at the border crossing points enable border guard officers to detect any irregularities of radiation field along a vehicle containing natural radioactive materials, which may suggest that those materials are screening other sources transported with the declared cargo, and to identify the nature of the detected sources.

In 2006, the portals indicated 18 500 incidences of an elevated level of radiation. The vehicles were turned back and entry into Poland was denied in 127 cases, since either the transported goods (e.g. transported radioactive

TABLE 1. RADIOACTIVE SOURCES AND NUCLEAR MATERIAL AT THE POLISH BORDER

Year	No. of interventions	No. of denials of entry
1990	4	—
1991	8	3
1992	148	47
1994	461	79
1995	1648	867
1996	11 847	409
1997	14 978	487
1998	13 866	285
1999	16 945	133
2000	12 382	23
2001	13 490	130
2002	16 842	84
2003	19 559	48
2004	17 807	165
2005	18 108	138
2006	18 419	127

sources or contaminated scrap metal) could not be used in Poland without a licence, or the source of the radiation could not be determined and documented. As can be seen in Table 1, the highest numbers of such denials of entry took place in the mid-1990s, reaching 800 cases in 1994. This shows that, at that time, the control and inventory of nuclear and radioactive materials could not have been adequate in some States, and that companies transporting scrap metal or other likely contaminated goods did not check or have regard for radioactivity in their shipments. Another reason could be the higher awareness in those days of Polish border guard officers to any readings indicating elevated levels of radiation in the examined transports, which at the time was justified by the occurrence of several attempts of illegal shipments of various undeclared goods (‘red mercury’ time), as well as the lack of proper procedures applied in cases of alarms caused by higher amounts of natural radioactive elements in fertilizers, ceramics, construction materials or non-radioactive metallic ores. In the last 2–3 years, no shipments of radioactive sources and nuclear materials which could have caused a serious radiation hazard have been intercepted, except an illegal transport of a 0.1 Ci ^{85}Kr source in a thickness meter for the textile industry and lower activity ^{226}Ra in the form of sealed sources (warning signs from some military equipment) and items contaminated by radium dye. One incident could have been connected with an attempt of illicit trafficking on a larger scale: the intercepted 6.35 g of uranium (depleted) was carried by a passenger to be tested by the potential customer interested in purchasing a bulk amount of enriched uranium. The majority of the interceptions are, however, due to radioactive contamination of scrap metal, timber and some food products coming from countries in eastern Europe.

At present, for all ambiguous cases, checkpoint staff may request advice from the duty officers of the NAEA Emergency Centre. During the first half of 2007, in which the portals detected increased radiation in 4722 cases, there were more than 1600 such consultations (in about 1400 cases, the controlled vehicles were loaded with material containing natural radioactive elements) and in 28 cases the vehicles were denied entry. When the situation requires it, the duty team from the Centre may intervene at the border as an emergency intervention squad in a mobile laboratory, investigating the case and, if needed, collecting material for further examination at the laboratory and placing it in the radioactive waste depositary. As was stated above, the border guard patrols also apply to portable radiometers, as well as mobile laboratories (also equipped with devices for the detection of other non-radioactive smuggled goods) which may be used, for example, at the cargo zones of airports, or within the State border zone.

4. FUTURE DEVELOPMENT

As of 1 January 2008, when Poland enters the Schengen system, the radiation monitoring portals on the 1900 km long border with European Union States are going to be gradually dismantled and radiation control will be executed only by border guard patrols equipped with portable instruments and operating within the border zone using mobile laboratories with sophisticated radiation measuring devices. The monitoring system on the outer European Union border will be upgraded through the gradual replacement of all the stationary portals by more sensitive gamma ray and neutron meters, and through extension of the existing information technique, including the introduction of the radioactive alarm and video event notification (RAVEN) system. A wider use of gamma ray spectrometry is also predicted, as is equipping all border guard patrols and officers with adequate portable instruments. Application of gamma ray spectrometry will enable the officers to identify the transported materials on the spot and to uncover shipments when some radioisotopes (e.g. caesium or cobalt sources) might be transported together with ‘screening’ by materials containing ^{40}K or other natural radioactive elements.

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ILLICIT NUCLEAR TRAFFICKING IN ASIA AND HOW TO PREVENT IT

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Abstract

Asia is witnessing an increased occurrence of illicit trafficking of nuclear and other radioactive material. The main factors responsible for this increase are the existence of a large number of nuclear countries, terrorist groups and countries with ongoing nuclear programmes in Asia. Moreover, four Asian nuclear countries are not signatory to the Nuclear Non-Proliferation Treaty (NPT), and are thus not under obligation by the treaty to limit the spread of nuclear weapons. Besides, countries through which most nuclear trafficking routes pass are mostly underdeveloped, poor with weak government institutions and may not have the capability to secure their national borders effectively. To combat nuclear trafficking effectively, States should have an efficient national system with an appropriate procedure and an agreed communication system among various national agencies. These measures will enable States to implement their obligations outlined in the International Instrument by the IAEA and to respond quickly to a critical situation. In addition, increased cooperation among governments will contribute to augmenting international security and public safety, and will achieve global non-proliferation objectives. In this connection, the international community should support national efforts by providing resources, training and coordinated assistance where needed. The international community should also promote universal adherence to the NPT and pursue countries of concern (those undermining the NPT) so that the NPT is not undermined and treaty pillars are respected accordingly.

1. INTRODUCTION

"The risk of nuclear terrorism is the worst of all nightmares" (M. Bremer Maerli, Norwegian Institute of International Affairs).

Since the terrorist attacks of 11 September 2001, it has been assumed that terrorist and non-State groups will attempt to steal weapon useable nuclear material to build nuclear weapons. Besides, concealed nuclear arms programmes being conducted by various countries are on the rise, particularly in Asia. Asia has also witnessed an increased occurrence of illicit trafficking of nuclear and other radioactive materials in the recent past. Many analysts believe that the following factors are responsible for this increase:

— Sources of weapon useable nuclear and radioactive materials. Presently, the number of nuclear countries in Asia is high, that is, the Russian Federation, China, Israel, India and Pakistan [1]. These countries possess a significant stock of high enriched uranium (HEU) and plutonium. The largest inventory in the world is held in the newly independent States of the former Soviet Union. They hold enough material to produce about 40 000 nuclear weapons. The Russian Federation holds approximately 99% of it with smaller stocks held in other newly independent States of the former Soviet Union, that is, Kazakhstan, Belarus, Ukraine and Uzbekistan [2].
— End-user (non-State groups). A large number of terrorist groups wanting to steal weapons useable nuclear materials are based in Asia, including Al Qaeda, Jemaah Islamia and the Aum Shinrikyo Cult [3].
— End-user (States). A large number of countries believed to have ongoing nuclear programmes are located in Asia, for example, the Islamic Republic of Iran, the Democratic People's Republic of Korea, Israel and the Syrian Arab Republic [4].
— Non-signatory States of the Nuclear Non-Proliferation Treaty (NPT) [5]. Currently, only four Asian countries are not signatory to the NPT. They are India, Pakistan, Israel and the Democratic People's Republic of Korea. Except Israel, all of them have openly tested a nuclear bomb. Israel is believed to have an ongoing nuclear programme. The Democratic People's Republic of Korea initially ratified the NPT, then violated the Treaty and later withdrew from the NPT [6]. These countries being non-signatory to the NPT have no obligation to limit the spread of nuclear weapons as outlined in the Treaty.

Besides, countries through which most nuclear trafficking routes pass are mostly underdeveloped, poor and may not have the capability to secure their national borders by installing radiation detection equipment to monitor nuclear trafficking. Moreover, some nuclear countries such as Pakistan lack technological advancement and expertise for safeguarding nuclear facilities and materials [7]. All these factors contribute tremendously to the flourishing of illicit nuclear trafficking in Asia, particularly in southern Asia.

Following the trend of an increased number of incidents of nuclear trafficking, governments in Asia recently took various steps to curb the incidence of nuclear trafficking, particularly using the instrument of export control and non-proliferation legislation. Some States introduced new legislation and related regulation to tighten the export control of nuclear materials and technologies. Some of the developments are appended below [8]:

- India introduced a new law on 6 June 2005, entitled Weapons of Mass Destruction and Their Delivery System (Prevention of Unlawful Activities);
- Malaysia's Parliament passed the Chemical Weapons Convention Bill (2004), in May 2005;
- The newly independent States of the former Soviet Union made a major change in their export control system in 2005;
- Recently, Kazakhstan and Kyrgyzstan carried out radioactive source search and record activities. They managed to secure and dispose of 1000 items of radioactive materials deemed to be vulnerable to theft and terrorism.

Moreover, Singapore, Brunei Darussalam, Cambodia, Fiji, Vietnam, the Republic of Korea, Japan, China and the newly independent States of the former Soviet Union also took pragmatic steps to strengthen non-proliferation regulation and to prevent trafficking. As a whole, the overall progress has been satisfactory, yet much more progress is needed using all other national instruments and means to prevent and combat illicit nuclear materials trafficking.

This paper examines the scale of the nuclear trafficking threat, and trafficking routes in Asia in general and southern Asia, in particular. Finally, considering the trends of nuclear trafficking and the capability of States to combat such trafficking, a programme for preventing and combating illicit trafficking in nuclear material will be suggested.

2. AIM

The aim is to examine the weapon useable nuclear materials trafficking trends and routes in Asia in general, and southern Asia, in particular, and suggest a programme for preventing and combating it.

3. SCALE OF THE THREAT AND TRAFFICKING PATTERNS

The illicit trafficking of nuclear materials involves a wide range of actors and encompasses various types of technology and methods of operation. It is very important to know and understand the ways in which States and non-State groups acquire nuclear materials. This knowledge will enable all States and the international community to take punitive actions to prevent and combat nuclear trafficking.

Entire nuclear weapons are usually never trafficked on the black market. Instead, their various components are transferred as nuclear materials. In Asia, particularly in south and southern Asia, the recent nuclear trafficking pattern can be broadly categorized as follows [9]:

— In this pattern, the black market procurement networks are connected to different States' arms programmes. The networks employ individuals and firms as intermediaries and suppliers in various countries in the region. These suppliers maintain a close liaison with States pursuing concealed nuclear programmes and supply them with a range of nuclear materials, and technologies — even blueprints, etc. — as required. Both Pakistan and India are believed to have pursued nuclear technology abroad for decades through some of these networks for their covert nuclear arms programmes;
— Another pattern is widely known as 'nuclear smuggling'. In this pattern, the smuggling is typically initiated by individual scientists or employees working with civilian or military nuclear facilities. Most of these initiators hide stolen nuclear materials in residences or on persons for subsequent clandestine transport. These individuals that are in a desperate financial situation get involved mostly for money. However, some of them may be ideologically or strategically motivated and others may be connected with organized criminal networks. Here the smugglers basically obtain nuclear materials from the newly independent States of the former Soviet Union and head to south and south-east Asia. The smuggled materials are mostly in minute quantities, which can only be used in a radiological dispersal device (RDD) or dirty bomb but not in a nuclear bomb.

Attempts to traffic or smuggle nuclear material following the patterns mentioned have doubled over the past five years [10]. Although the majority of cases involved material which is not suitable for making bombs, such as scrap metal or radioactive sources, there are cases which involved plutonium or HEU, which could be used in bombs. We must remember that it takes just a few kilograms of plutonium and less than 20 kg of HEU to make a nuclear bomb. This quantity would be relatively easy to transport and smuggle.

Recently, the southern Asian region has seen a flourishing of illicit nuclear trafficking proliferation. Some of the contributing factors of this increase are:

- The existence of a large number of source (nuclear countries) and end-user (States and non-State groups) in this region;
- Al Qaeda, Jemaah Islamia, the Aum Shinrikyo Cult and other terrorist organizations in this region are known to be interested in acquiring nuclear weapons [11];
- The concealed nuclear arms programmes of Pakistan and India have pursued nuclear technology and materials abroad for decades through licit and illicit channels. Networks which were involved with these countries are still active, for example, the Pakistani scientist Abdul Qadeer Khan's network (known as the Khan Network). It is believed that the network along with some of its agents is still active and that the network is operating from south and south-east Asia to the Middle East, Africa and Europe. This network is believed to have equipped the Islamic Republic of Iran, Libyan Arab Jamahiriya and the Democratic People's Republic of Korea with centrifuge equipment, as well as blueprints and the technical know-how needed to produce HEU [12];
- The war-like situation between Pakistan and India contributes directly and indirectly to the flourishing of illicit nuclear trafficking in south and south-east Asia. Due to this tense situation, both countries are involved in a serious arms race, which ultimately led them to acquire nuclear power through both licit and illicit ways. Besides, to acquire more military hardware, the Khan network was presumably involved in transferring nuclear materials from Pakistan to the Democratic People's Republic of Korea in exchange for missile and missile technology from the Democratic People's Republic of Korea to Pakistan;
- Acquisition of a nuclear reactor by Myanmar from the Russian Federation may contribute to an increase in nuclear trafficking in this subregion. Myanmar, in collaboration with China and other nuclear networks, may try to achieve a nuclear weapons capability [13];
- Existing or planned nuclear research reactors and power plants in countries such as Indonesia, Thailand and Vietnam, might also have contributed to trafficking proliferation risk, although the extent of such risk may not yet have been fully comprehended by reporting on nuclear trafficking in this area.
- Pakistan and India's nuclear facilities [14] are not subjected to IAEA safeguards [15]. They lack technological know-how and expertise for safeguarding nuclear facilities and materials. The following incidents amply demonstrate that their nuclear installations are poorly protected and are vulnerable to trafficking [16]:
  - In April 1974, uranium from Jaduguda Uranium Mine Complex, Bihar, India was smuggled to Hong Kong Special Administrative Region of

China via Nepal. Later, Chinese or Pakistani agents reportedly took delivery from Hong Kong Special Administrative Region of China;

- In 2001, uranium smuggled from Jaduguda Uranium Mine Complex was confiscated from suspected terrorists in Balurghat (northern West Bengal). It was planned to be smuggled across the Bangladeshi border;
- In 2001, Khan arranged a delivery of 1.87 T of UF_6 on a Pakistani airline flight, directly from Pakistan to Libyan Arab Jamahiriya. In addition, the network sent a centrifuge unit by airplane directly from Pakistan to Libyan Arab Jamahiriya between 2001 and 2002 [17];
- Vijay Times, 30 April 2006, reported that smugglers were sending highly radioactive yellow cake (processed uranium) to Nepal using a clandestine narcotic route via Jharkhand-Bihar, West Bengal conduit and it is suspected that the destination might be Al Qaeda;
- Most south Asian countries are not capable of effectively securing national border and maritime routes due to a lack of resources (radiation detection equipment) and training. Besides, in Central Asia, the newly independent States of the former Soviet Union possess nuclear material technology and human resources. However, they are not fully capable of protecting them from diversion to States and non-State groups wanting nuclear technology and material due to poor economies, weak government institutions, poorly managed export control, etc.;
- Smugglers are overoptimistic about the possibilities of making financial profits by trading in nuclear and other radioactive materials and related products. This belief encourages them to get engaged in nuclear trafficking in this region.

According to some experts, nuclear trafficking in this region can be described as ‘supplier driven’ [18]. Existing criminal networks usually resort to nuclear trafficking as it can be carried out with relative ease along some of the same routes (narcotic drugs and conventional arms smuggling routes) by the same criminals with little hindrance by authorities or border control. The countries covered by the network include Pakistan, Malaysia, South Africa, Turkey, United Arab Emirates, Japan and a number of west European countries. The networks also reportedly made contact with the Islamic Republic of Iran, Democratic People’s Republic of Korea, Libyan Arab Jamahiriya, Syrian Arab Republic and Saudi Arabia, in recent decades [19].

4. NUCLEAR TRAFFICKING ROUTES

Beside land routes, smuggled nuclear materials are usually shipped abroad using legitimate means of transport and aircraft with the help of end use declaration. Some of the recently used routes are appended below [20]:

- The land route following the existing narcotics trafficking routes (including old silk roads) from Kazakhstan, Turkmenistan, Uzbekistan and Tajikistan into Afghanistan and Pakistan (border city of Peshwar). Peshwar has been identified as a major point of sale of nuclear materials and alloys for nuclear weapons. From Peshwar, nuclear materials then potentially continue on to the Islamic Republic of Iran, India or south-east Asia;
- The land route from Pakistan to the Democratic People's Republic of Korea passes through Pakistan's Karakoram highway to China, and then through Chinese territory;
- The transport route between the Russian Federation and the Islamic Republic of Iran through Azerbaijan;
- The Pakistan–Islamic Republic of Iran land route passing through Pakistan's south-western Baluchistan Province (an old trafficking corridor);
- The land route from India (Jaduguda Uranium Mine Complex, Bihar State) into Bangladesh (across the Indian eastern border) and then heading north–northwest to Nepal, then passing clandestinely through the mountainous route to Pakistan or Jammu and Kashmir for militants of the disputed areas. Another land route passes from India into Bangladesh and then potentially continues into Myanmar across Bangladesh's south-east boundary [21];
- The sea route between Pakistan and the Democratic People's Republic of Korea following the Arabian Sea, via the south of India, continuing through the Malacca Straits, and then heading northward into the South Sea and the East China Sea, presumably passing through Chinese waters. Singapore or Hong Kong Special Administrative Region of China may be used as trans-shipment points;
- The sea route between Pakistan and Dubai (through the Arabian Sea and the Persian Gulf), and Malaysia and Dubai (through the Arabian Sea and then into the Persian Gulf by way of the Straits of Hormuz). Dubai is reportedly being used as a major trans-shipment point for a number of cargoes to the Islamic Republic of Iran and Libyan Arab Jamahiriya;
- The sea route between South Africa and Pakistan. This route passes through the Indian Ocean and then heads north into the Arabian Sea;

— The air route from Dubai to Pakistan. Recently, A. Karni, an Israeli middleman, apparently shipped US made high speed triggering devices for nuclear weapons to Islamabad, Pakistan, via a DHL freight-forwarding service aboard an Emirates Airlines flight from Dubai.

5. SUGGESTED MEASURES FOR PREVENTING AND COMBATING ILLICIT NUCLEAR TRAFFICKING

Illicit trafficking of nuclear materials continues to pose a global proliferation risk and a potential danger to public health and safety. Existing international non-proliferation and export control measures as well as cooperation on intelligence gathering are largely inadequate in detecting, preventing and combating nuclear trafficking. Moreover, national systems and instruments to combat trafficking in many States of Asia are mostly inadequate. In order to prevent nuclear trafficking, countries of this region need to take punitive and proactive measures. The international community has taken important steps to strengthen the platform of the international instrument, which contains obligations for States. States should implement those obligations religiously to combat nuclear trafficking. The following are a few suggested measures and steps to prevent and combat nuclear trafficking:

— Each State should have an effective national system for combating illicit trafficking by establishing appropriate key components, that is, a nuclear and radiation safety authority, a law enforcement authority, etc. with a national supervisory authority at the apex;
— State law enforcing agencies employed at international borders, airports and seaports should be fully trained and equipped to detect radioactive materials. Most countries of the newly independent States of the former Soviet Union, south and south-east Asia may not have the capability to monitor all trafficking. This may lead to under-reporting or misreporting of a proliferation incident. Both misreporting and under-reporting are undesirable as they distort the knowledge of nuclear trafficking. The prospect of undetected nuclear trafficking needs to be taken seriously. To do so, States should organize nuclear trafficking awareness training at regular intervals. We suggest that the IAEA provide training, coordination and equipment support to States that need it;
— States should establish appropriate procedures that are agreed in the national system for coordination. All the concerned authorities and agencies in the national system should have an agreed communication system so that they can all respond adequately and quickly to a critical situation;

- States should maintain effective national systems of export licensing and control, which are important to deter and prevent illicit trafficking;
- States' supervisory authorities should establish cooperation with authorities of other countries and international organizations, that is to say, national nuclear focal points must be in communication with their counterparts at the international level, i.e. INTERPOL, the World Customs Organization (WCO), and the radiation and safety authority in the IAEA. Besides, States should promote cross-border cooperation between law enforcement agencies at the regional and subregional levels;
- In Asia, States of different regions such as south and south-east Asia, Central Asia, the Middle East and east Asia should be able to benefit from combining their resources at a regional base for combating nuclear trafficking. Such a region could establish cooperation on intelligence gathering and sharing, which would be beneficial for increasing knowledge, effective monitoring and responding to smuggling;
- Only four Asian nations are non-signatory to the NPT. The international community should try and pursue these nations so that they become party to the NPT;
- States should implement their obligations outlined in the international instrument by the IAEA. We suggest that the IAEA establish a monitoring cell at the regional level to monitor the implementation of the obligations by States. The regional cell could have a frontline office at State level to monitor, advise and assist States on the issue;
- States should follow the treaty pillars of the NPT strictly. As per the first pillar (non-proliferation), nuclear weapon States agreed not to transfer "nuclear weapons or other nuclear explosive device" and "[n]ot in any way to assist, encourage, or induce" a non-nuclear weapon State (NNWS) to acquire nuclear weapons (Article I). NNWS parties to the NPT agreed not to "receive", "manufacture" or "acquire" nuclear weapons or to "seek or receive any assistance in the manufacture of nuclear weapons" (Article II) [6]. However, the recent USA–India nuclear energy deal has come under controversy as it undermines the NPT. The international community should promote universal adherence to the NPT and pursue the concerned countries so that the NPT is not being undermined and treaty pillars are respected accordingly;
- Nuclear countries should ensure safe and secure storage of nuclear material. Although the storage and control of nuclear material is a national responsibility, we suggest that the IAEA support national efforts by providing resources, training and coordinated assistance where needed;

- Only 4 kg of plutonium is needed to make a plutonium bomb. A small reprocessing facility can produce 12 kg of plutonium per year [22]. As such, all civilian nuclear reactors are the easiest sources of plutonium for terrorist groups. Besides, any country wishing to pursue a clandestine weapons programme can extract the required plutonium by reprocessing. Therefore, all nations should ensure monitoring, protection, control and accounting of nuclear materials of all civilian nuclear reactors within their territory. The IAEA should oversee this issue;
- We suggest that the IAEA organize conferences, symposiums and workshops at the international and regional level on illicit nuclear trafficking with the participation of all concerned at regular intervals.

6. CONCLUSION

The threat of illicit nuclear trafficking is increasing. Alongside States, many non-State groups (Al Qaeda, Jemaah Islamia, the Aum Shinrikyo Cult, etc.) in Asia are trying to acquire nuclear capability. Some analysts opine that there could be as many as 130 terrorist groups that pose a nuclear threat. Presently, in Asia there are many countries that are believed to have an ongoing nuclear programme. These States, non-State groups and nuclear countries in Asia are all directly or indirectly contributing to increasing trends of nuclear trafficking in Asia. Most countries in Asia are signatory to the NPT, but many of them are unable to implement the obligations outlined in the Treaty due to financial incapability and weak government institutions.

To combat nuclear trafficking efficiently, States should have a competent national system capable of performing their obligation effectively. Besides, increased cooperation among governments will contribute to increased international security and public safety, and will achieve global non-proliferation objectives. Therefore, we should strengthen our collective response by:

- Promoting enhanced cooperation and coordination among national intelligence, customs and law enforcement agencies and cooperation with those of other countries of concern;
- Regularly sharing and promptly disseminating information between the concerned agencies within countries and in neighbouring countries;
- Exchanging experience and advice among ourselves and making it available to neighbouring countries.

To combat illicit trafficking, the State supervisory authority should establish communication and cooperation with international organizations, that is, the IAEA, WCO and INTERPOL. We suggest that the IAEA provide courses, training support, information and coordinated assistance to States where needed.

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DISCUSSION

SESSION 3: International Initiatives and National Efforts to Establish Capabilities — I

I. GILL (United Kingdom): In the breakdown of your detection figures, I. Kuzmyak, only a small percentage were shown as unauthorized possessions compared to 57% as 'discoveries'. Your definition of discoveries included law enforcement actions. What law enforcement actions would not lead to them being unauthorized possessions?

I. KUZMYAK (Ukraine): Some law enforcement activities are provided for in the framework of the Law on Physical Protection and are applied to the nuclear security of facilities and other objects or to searching for lost sources. Law enforcement authorities often cooperate with other authorities. Some law enforcement activities are covered by the Law on Fighting Terrorism and by the Law on Search and Investigation Activities. Such activities may be confidential, carried out by specially designated enforcement divisions and are aimed, for example, at identifying the probable owner of the discovered radioactive material. Such a situation arises when an authorized owner decides to dispose of a spent unregistered source and it is defined as a malicious act.

M. MAYOROV (IAEA): L. van Dassen, in your presentation about the Kola project, you mentioned that you faced several difficulties with the Russian Federation authorities during the implementation of Phase 1. We know of existing experience in the implementation of nuclear security equipment at the Russian Federation border under the SLD programme. Have you ever considered requesting Russian Federation customs experts to share their experience or involving an international organization to provide additional support for the project?

L. VAN DASSEN (Sweden): Initially, we accepted the requirement of our Russian Federation partners that the project would start as a Russian Federation–Swedish partnership. Now that the footwork has been done, we are ready to work with more parties. I would not say that we had difficulties working with our Russian Federation counterparts. It was difficult to define what to do as we were on virgin soil. The project is our crown jewel thanks to the dedication and commitment of the persons and institutions involved in the Russian Federation. Informative monthly reports reach us punctually, meetings are productive and the spirit positive. We are doing what the Russian Federation would do itself if it had the resources. We do it for the Russian Federation's sake and for ours.

D. HUIZENGA (United States of America): The progress in the project is to be commended. With over 350 border crossings to cover, there is extensive cooperation with Russian Federation customs, and a plan and a path forward to complete the work in the next few years. The Russian Federation is funding more than half of the work. It is important for us to recognize that.

SESSION 3: International Initiatives and National Efforts to Establish Capabilities — II

A.J. AL KHATIBEH (Qatar): (1) Several hundred illegal shipments were denied entry to Poland. Is that sufficient, or should a different approach be pursued? (2) Several countries were named as major route points for the illicit trafficking of nuclear material. Is there any evidence of this?

J. NIEWODNICZAŃSKI (Poland): (1) Maybe it is not very fair to deny entry because we leave the problem to our neighbours but it is practically, and legally, the easiest way. We detect elevated levels of radiation and simply turn the shipments away without necessarily knowing what caused the increase. Sometimes we know; for example, shipments of mushrooms from forests in the Chernobyl region or contaminated scrap metal from Kazakhstan, and we still deny entry without comment. This is our current policy, enforced by our border guards.

G.M. SOLAIMAN (Bangladesh): (2) I developed my paper from secondary sources (Internet) and various other references (listed in the paper).

J.L. PAREDES GILISMÁN (Cuba): This is a recommendation to my colleague from Azerbaijan and also to other colleagues. I would like to put forward the idea of developing an electronic basic theoretical course for customs officials covering topics such as understanding and dealing with radiation, import/export regulatory requirements, use of radiation detection equipment, and dealing with radiation emergencies. An electronic certificate could be issued to mark completion as the IAEA does for its Security in the Field courses. This could be of assistance to customs authorities with a high turnover of personnel. Such a programme would not be expensive and many persons can use it at once. Customs personnel can refresh their knowledge at any time and the regulatory authority can update the information on the software whenever necessary. I believe that such an e-course and train the trainer courses run by the customs authorities could help to resolve this problem.

R.A.A. RAJA ADNAN (Malaysia): Data obtained from cyberspace is not always reliable and needs to be verified. In this regard, the Bangladeshi speaker's allegations about nuclear trafficking from south-east Asia should be substantiated. It could be just noise. Moreover, his definition of illicit nuclear trafficking seems to be different from the one generally used.

PANEL 1

LESSONS LEARNED

Chairperson: **R.A.G. Hoskins** (IAEA)

Members: **S. Elegba** (Nigeria)
S. Aoki (United States of America)
R.A.A. Raja Adnan (Malaysia)
A.J. Al Khatibeh (Qatar)
J. Niewodniczański (Poland)

Scientific Secretary: **B.H. Weiss** (IAEA)

PANEL 1

Lessons Learned

R.A.G. HOSKINS (IAEA): We are going to try to capture the lessons learned from the first two days of presentations. The distinguished panel will individually make a brief commentary on the lessons that have impressed them during the past two days, after which the discussion will be thrown open for your comments. I hope we have a fruitful discussion that will be the groundwork for assembling good findings from this conference. Two main points stand out for me: (1) It has struck me — from yesterday's session — that there is clearly an international consensus that the threat of nuclear terrorism is very real. The threat has two components: intentions and capability. On intentions, there seems to be a high level of consensus. Capability combines two elements: technical capability to assemble a bomb (which we have not addressed) and the availability of the material, which is at the core of the whole illicit trafficking debate. We had a very interesting discussion on how to characterize the information we have on illicit trafficking and what it tells us about the threat. That information can be broken down into that which has direct relevance to the threat — showing evidence of malicious intent or preparations to use material or to seek it by a non-State or terrorist group — and that which has indirect relevance to terrorist groups acquiring material. The indirect evidence shows us vulnerability and weaknesses in the prevention and detection systems because if prevention systems fail, the material has a potential for becoming available and the capability is achieved. (2) A question raised by Deputy Director General Taniguchi in his comments was: Is the international community doing enough? Can we do better? For these questions, the international community can be seen in two ways. Are we — as individual States in our own programmes — doing enough and how can we do better? We have heard some excellent presentations on national capabilities that range from problems in a State with very limited resources reflected in D. Muleya's presentation to — perhaps at the other end of the scale, in S.Y. Mohd's presentation on Malaysia — a highly sophisticated way of collecting information on trafficking, and managing and responding to that information using the infrastructure that they are building. At the international level, what can the international community do better? (a) Do we need to improve international instruments? (b) Do we need to strive to improve the already high level of international cooperation? (c) Do we need to explore ways of giving assistance, where necessary, that are effective, efficient and sustainable? Sustainability is a theme we should focus on.

S. ELEGBA (Nigeria): We — especially the developing countries — have come a long way but there is still a lot to be covered. With reference to the Notification and Assistance Conventions, especially in developing countries, nuclear safety and security issues used to be considered as something exclusively for scientists and engineers. But today we know that these issues go beyond any particular discipline; it is the responsibility of the whole country. That is why we now have multi-agency/ministry cooperation (e.g. defence, customs, health). We have come to realize that nuclear security — addressing loss of control, whether through theft, trafficking or negligence — is the concern of the entire country and the response must be holistic. Thus, we have done something but we need to do more. The way forward shows that there is a gap, which is becoming bigger even between developing countries. I refer to extremes such as the examples cited earlier: Malaysia versus Zambia. There is a lot to be done, which requires cooperation at both the regional (even subregional) and the international levels. Sometimes techniques used, say, by the USA, would not be applicable in Zambia but Nigeria would be able to relate better to conditions existing in the area and see what needs to be done. Finally, while appreciating the graded approach, I note that the international community seems to have focused on illicit trafficking in countries of the former Soviet Union and the rest of the world seems to have been neglected because of that particular problem. This is understandable, nevertheless, security needs to be integrated worldwide.

A.J. AL KHATIBEH (Qatar): My comments are centred on two points. Firstly, a remark made by a member of the audience today concerned defining the problem. If we do not know what the problem is, how can we go forward? In my view, the world community does know what the problem is — illicit trafficking of nuclear material has become a very serious business in the last few years. While we acknowledge that the probability of using a dirty bomb (or radiation dispersal device (RDD)) or an improvised nuclear device is very low, we all know that the consequences would be horrendous. At the International Conference on the Security of Radiation Sources in March 2003, it was felt that the use of an RDD was just a matter of time. Fortunately, it has not happened. Is this because we overestimate the threat or because the world community is doing the right thing? We will never know, but we do know that we have done a great deal to enhance our national nuclear security systems since 2003. My second point is that many have asked whether the investment is justified. When we started our border project in Qatar, which cost around $5–7 million, many asked this question. That same year, one of the local teams bought a football player for $20 million. I think protecting one million people is definitely worth a quarter of a football player.

S. AOKI (United States of America): My reactions are similar to some of those we have heard. I was struck by the broad international participation and by the degree of convergence in the presentations given over the past two days. There is a common acceptance that this is a problem confronting the entire international community — not just the developed countries, the former Soviet Union or some subset of European countries — and approaches to the problem have quite a lot in common, constrained by resources, differences in national law and situation, but still relying on the same international instruments and, increasingly, on bilateral and multilateral cooperative activity. So there is much consensus. Part of this consensus is that we need to concentrate not only on equipment and border control but also on frontline officer training, a theme arising in many of the presentations. Training for personnel is hard to sustain but is vital to making the investment worthwhile. My second question is whether there is really a problem and, if so, have we scoped it correctly? After hearing the statistical presentations, I realize that we are looking at two or three different things. There is clearly a continuing background problem revolving around negligence with contaminated material, which will always be with us and needs to be addressed. Then, there are people with criminal intentions, trafficking for financial gain or for ideological motives. Finally, there is the ‘needle in the haystack’ — which is why we are making such great efforts — that is, trafficking for terrorist purposes, as a precursor to some horrendous terrorist attack. In today’s world, we need to be taking defensive measures against that problem above all. Our governments have the responsibility to protect people and the world community against something that could have such enormous consequences. Turning to the way forward, those of us engaged in cooperative activities should continue to focus on training and sustainability. As we accumulate more experience and understanding of what we observe with regard to trafficking, we need to bring together the law enforcement, intelligence and technical community, and examine our strategic approaches to deploying our prevention and detection capabilities/systems. Several speakers noted that we place a lot of emphasis on legitimate border crossings and fixed portals. We may need to begin thinking about the stretches of borders that lie between. Also, we need to pay attention to dealing with the aftermath of a successful detection. What happens then? Who takes charge of the material? How is it disposed of? How is it analysed to relate it to other cases, potential threats or possible perpetrators? There is still much that is worthy of our attention but we have also made a lot of progress.

J. NIEWODNICZAŃSKI (Poland): I think that the problem is real and it is just a matter of time until we witness the explosion of a dirty bomb, which would have enormous psychological effects. This would create a lot of problems for the nuclear industry all over the world, applications of sources for medicine and so on. We have to be serious even if an RDD explosion does not seem to be very probable. The main way to combat illicit trafficking that could lead to such an event is prevention — through the national system of accountancy, of physical protection, of maintaining a register of sources, of controlling all radioactive material. I am more afraid of radiological than nuclear material because usually nuclear material is better controlled. Prevention systems should be built on a properly defined legal structure, supported by international legal instruments. Finally, not only international but also regional cooperation is important since borders are between countries, so neighbours need to cooperate well.

R.A.A. RAJA ADNAN (Malaysia): The international community and, in particular, the IAEA have done very well in raising awareness about the impact of illicit trafficking. The IAEA Department of Safety and Security, Office of Legal Affairs and Department of Technical Cooperation have helped developing countries to strengthen their legal infrastructures, the integration and coordination of the agencies responsible for combating illicit trafficking, and the necessary hardware and software. The IAEA has limited resources, and the Office of Nuclear Security is largely dependent on voluntary funding, so it has to operate within that limitation. However, we see a lot of donor funds coming in, so never mind about donor fatigue. We as recipients, too, sometimes seem to have recipient fatigue. As we see a lot of effort made and assistance given, we much appreciate the coordination that can be organized through the IAEA to render the assistance more cost effective and to really help us. As to the legal instruments, we note and appreciate the value of adopting the Code of Conduct but it should become a binding convention to be really effective in ensuring proper control of radioactive sources. Since Malaysia has become involved in combating the black market, we no longer look at ourselves as insignificant with regard to nuclear and radioactive material, and we take the problem of illicit trafficking very seriously and recognize the global threat.

R.A.G. HOSKINS (IAEA): I now throw the floor open for your observations and comments.

O. GONCALVES (Brazil): Referring to my provocative question this morning about whether there was really a problem and whether we were addressing it correctly, I know quite well that there is a problem. However, there are many other points that should be addressed. For example, the Goiânia accident is a symbolic event because it is the kind that could be caused by an RDD. But is it real? Now people spoke about a cobalt source. This is metallic, not powder. Even caesium (the source involved in Goiânia) is now metallic. Therefore, the effect would not be the same. Chemical and biological bombs were mentioned as a comparison. This is not valid. Radiological incidents could be better defined and handled. This kind of question has not been addressed in the last two days. I am looking for more profound scenarios that enable us to understand whether trafficking is the only problem we have here.

S. ELEGBA (Nigeria): Interestingly, we do not have many manufacturers here. I thought that after the Goiânia accident, which involved caesium chloride, source production would gradually move to a form — solid metallic or ceramic — that was not soluble and not as easily dispersible. One could look for solutions here too — in the technology for manufacturing sources. In this regard, it would be good to know what R&D is happening to minimize the potential hazard posed by sources.

A.J. AL KHATIBEH (Qatar): Regarding the cobalt source, terrorists rely on public perception — rather than actual physical effects — and in this case, people would panic regardless of the form, whether powder or metallic.

R.A.G. HOSKINS (IAEA): If there are no more comments or questions, the points made will be taken into account in the conference findings. A few points struck me in particular. Firstly, engaging the technical and scientific community with the intelligence and law enforcement community to ensure the most effective deployment of detection technologies is a point well made. The problem requires the combined effort of all those who have a stake in and knowledge about combating illicit trafficking. Secondly, prevention is the key element. If intentions and capability come together to form a threat, denying the availability of material greatly diminishes the threat. Somebody once said $1 spent on prevention is worth $25 spent on detection. Thirdly, concerning regional cooperation, sometimes our focus on international cooperation diverts attention from regional cooperation and networking opportunities to share experience. We should direct more attention to it in the future for obvious reasons and also because every border has two sides to it; so border problems are shared by potential partners in solving them. I thank you — the panel members and the audience — for your insights and your attention.

ESTABLISHING CAPABILITIES TO DETECT ILLICIT TRAFFICKING

(Session 4)

Chairperson

S. DABAI
Nigeria

Rapporteur

N. EVANS
Canada

IAEA-CN-154/074

BUILDING AN EFFECTIVE ILLICIT NUCLEAR TRAFFICKING DETECTION ARCHITECTURE*

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Not just one, but a series of combined events has led, through an abundance of prudence, to a systematic development and deployment of a nuclear detection architecture in the USA. There have been troublesome reports that non-national terrorist entities have been striving to acquire nuclear material — both radioactive sources and weapons usable material — since the early 1990s. There have been two World Trade Center attacks using unconventional weapons, the second attack being fully successful. Threat streams of even greater attacks are continuing. The terrorist adversary has proven adaptive and persistent. Additionally, not all State actors have embraced the abolishment of terror tactics; thus, we cannot ignore those States as possible surreptitious users of nuclear or radioactive material as weapons, should diplomacy fail. We do not believe that nuclear stockpiles are one hundred per cent secure in some nations, and that diversions may have occurred or could still occur. Combine this with radicalism, motive and intent, and we are compelled to strive to create an effective detection architecture that may deter or prevent illicit nuclear or radioactive material trafficking. Our primary intent is to secure our borders and support our partners, and some of this work involves strengthening partnerships with other countries and entities, the IAEA being one of those entities. Arguably, there have been about 20 cases of illicit nuclear trafficking where actual weapons usable material was seized (many more in which other radioactive material was involved). This is 20 cases too many, and we cannot know whether this is only the tip of the iceberg. The paper describes the US Government origins of the development of an effective illicit nuclear

* The full paper was not available for publication. The synopsis appears in its place.

trafficking detection architecture, the centralized planning involved and the shared responsibilities of numerous US Government agencies. Our belief is that end to end planning, a robust nuclear forensics capability, a global initiative and other related activities are part of this architecture. Lastly, the paper offers an information sharing strategy, which will be imperative in order for our many systems to work together effectively.

IAEA-CN-154/084

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IAEA-CN-154/085

THE BRAZILIAN EXPERIENCE IN THE IMPLEMENTATION OF NUCLEAR SECURITY ACTIVITIES FOR THE 2007 PAN-AMERICAN GAMES

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Abstract

The actions taken by the Brazilian Nuclear Energy Commission (CNEN) related to nuclear and radiological security for the Pan-American Games and for the Para Pan-American Games, held in Rio de Janeiro, Brazil in 2007, are presented. This was part of a multi-institutional plan for the security of the games, coordinated by the National Secretary of Public Security of the Ministry of Justice (SENASP/MJ). The support provided by the IAEA under a cooperation arrangement with the Brazilian authorities was a key factor for the success of the whole operation. The organization and concept of operations adopted are described, and the results of the survey of venues before the start of the games and of the access control are presented.

1. INTRODUCTION

The Pan-American Games are a continental version of the Olympic Games, which include both Olympic sports and other disciplines suggested by the competition organization and approved by the Pan-American Sports Organization (PASO). Held every four years, the first Pan-American Games were held in 1951 in Buenos Aires, Argentina. For more than 50 years, the Pan-American Games have been held continuously and have been to numerous cities in all areas of the North and South American continents. Gradually, the Pan-American Games gained importance and significance. In less than a century, the number of countries, athletes and disciplines has doubled, and the

Pan-American Games have become one of the leading competitions in the international sport calendar.

The XV Pan-American Games 2007 and the III Para Pan-American Games were held in Rio de Janeiro, Brazil from 13 to 29 July 2007 and from 12 to 19 August 2007, respectively. Those events had 8700 participants including athletes, coaches and referees from 42 countries. More than 300 competition events were held at 17 different venues and were covered by 4910 professionals from television, radio and the written press. Around two million tickets were sold or distributed and 18 000 volunteers participated in the organization.

The organization of a major public event of this sort, in which a large number of spectators and participants are involved, presents important security challenges for a State, especially following the terrorist attacks during recent years and the increasing concerns with respect to malicious acts involving the use of nuclear and other radioactive materials at such events. For this reason, the Brazilian Nuclear Energy Commission (CNEN) was requested by the National Secretary of Public Security/Ministry of Justice (SENASP/MJ), at the end of 2006, to participate in the security actions to be implemented in both the XV Pan-American Games and the III Para Pan-American Games. This participation was concentrated on the implementation of specific nuclear and radiological security measures to be applied at those events and was part of a multi-institutional plan.

2. COOPERATION ARRANGEMENT WITH THE IAEA

Taking into account the challenges to be faced in the implementation of those security measures and based on the previous experience of the IAEA, especially in developing an effective security system for the protection against nuclear and radiological threats for the Olympic Games in Athens in 2004, after consultations with the IAEA (in particular, the Office of Nuclear Security), the Brazilian authorities, through its National Nuclear Energy Commission, formally requested IAEA support. In order to further discuss and assess needs, and to plan for such support, an expert mission from the IAEA met with officials from CNEN and SENASP in Brazil from 22 to 25 January 2007. As a result of this expert mission, a cooperation arrangement for providing advice and technical support between the Brazilian authorities and the IAEA was established, and a joint action plan was developed. The objective of this plan was to define the tasks to be jointly implemented by the Brazilian authorities and the IAEA to enhance the national capability to deal with the prevention, detection and response to criminal or other unauthorized acts involving nuclear and other radioactive materials at the Pan-American

Games. The joint action plan for cooperation consisted of technical support missions; training courses, seminars and exercises; development and revision of specific technical procedures; selection, provision and deployment of equipment; information exchange and analysis; and consultation on emergency preparedness and response.

Within the scope of the joint action plan, two technical support missions to review and provide advice on specific areas were conducted: the first about monitoring capabilities at venues and other relevant places, and the second on a specific response plan for the local mobile expert support teams (MESTs). Additionally, one seminar, two train the trainers courses and one exercise, with instructors from the IAEA and CNEN, were carried out for participants from all involved institutions:

- Awareness of the IAEA Illicit Trafficking Database (ITDB) [1], and trafficking patterns and trends seminar for senior officials;
- Training course on radiation detection at strategic locations for security personnel;
- Training course on response to criminal or other unauthorized acts involving nuclear and other radioactive materials;
- Field exercise on radiation detection for security personnel (frontline officers).

The above activities were conducted within a very short period of time, from 2 April to 22 June. The first seminar was important to present, especially to those institutions involved more directly in developing a threat analysis, a very important component of this task, that is the IAEA's ITDB. The IAEA provided a baseline assessment of illicit trafficking trends and patterns with an assessment of related risks by 12 April 2007. This was followed by periodic reports on relevant trafficking incidents and reports of lost or stolen sources — in particular within the Latin American region — which had been notified to the ITDB by States or which had been reported in the media and open sources. Such reporting was on a monthly basis starting from May 2007, weekly starting from June 2007 and in real time as events were reported starting from July 2007, as agreed in the joint action plan. In addition, as part of the joint plan, the IAEA sent the following equipment to be used during the games:

- Two kits (HPGe, neutron search detector, radionuclide identification devices (RIDs)) for use by MESTs;
- Five DG5 gamma search detectors for vehicle searches at checkpoints;
- One IEC ARC system for terrestrial mobile search;

- One hundred and eighty personal radiation detectors (PRDs) for detection at security gates;
- Twenty-one RIDs for categorization at security gates;
- Five portable spectral area survey systems (backpacks) for a pre-event area survey scan and MESTs.

The support provided by the IAEA under this cooperation arrangement was a key factor for the success of the whole operation.

3. ORGANIZATION AND CONCEPT OF OPERATIONS

To develop the concept of operations and also to coordinate the necessary actions, before and during the games, on 2 March, two working groups were nominated by the presidency of CNEN. The first one was the supervision and institutional liaison group that was composed of the directors and general coordinators of the involved groups, and was responsible for the decision making process and the liaison with SENASP and all other external institutions. The second working group was the tactic operational group that was responsible for the implementation of the actions in the field and was formed by CNEN's senior staff members. Both groups were formed by representatives from CNEN's headquarters and two of its institutes, the Institute for Radiation Protection and Dosimetry (IRD) and the Institute of Nuclear Engineering (IEN), all three being located in Rio de Janeiro, which facilitated the logistics of the operations.

Those two groups had seven joint meetings for the elaboration of the CNEN action plan where the concept of operations and the structure of the CNEN teams (Fig. 1) were defined. It was also decided, due to the very short time for preparation, to work preferably with portable detection equipment and to concentrate efforts in competition and other relevant venues.

3.1. General coordination

The general coordination was the decision making group, formed by the members of the supervision and institutional liaison group, and the coordinator of the tactic operational group. It was responsible for communication with the presidency of CNEN and the operational centre for the security of the games. This coordination was also the ITDB and the IAEA source catalogue focal point. The general coordination operated from CNEN's headquarters.

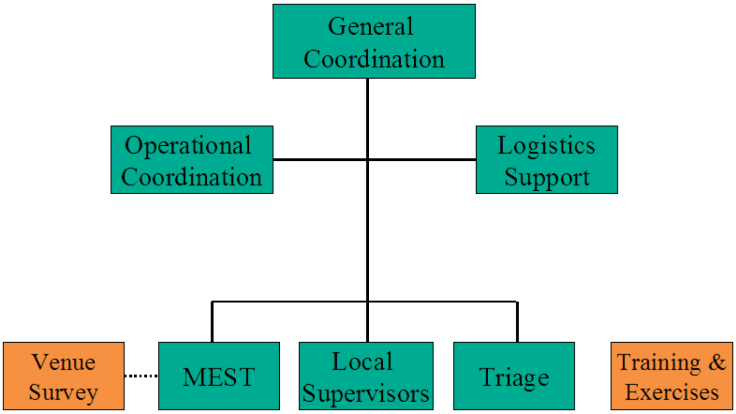

FIG. 1. Organizational structure of the CNEN teams for the Pan-American Games.

3.2. Operational coordination and logistics support

The operational coordination was responsible for the execution of the action plan, providing support for the general coordination, MEST and triage. The operational coordination was also the IAEA international emergency centre focal point. It was composed of four teams with six components each working on 12/36 h shifts. The basic composition of each team was one coordinator, one secretary, three officers (instrumentation, logistics and communications) and two drivers.

The operational coordination operated at the IRD premises due to the fact that it is routinely responsible for emergency preparedness and response coordination, so it already had the necessary installations for this type of operation and also it was very close to many venues, including the Pan-American Village. In order to better manage the deployment of triage teams to the venues far from the IRD, a secondary operational group was based at CNEN's headquarters consisting of one coordinator and two logistic support officers. The operational coordination was also responsible for the control and registration of the work time of each component of the different groups and to make the necessary arrangements to fill any gaps in the teams.

Working closely with the operational coordination was the logistics support group which was responsible for supplying infrastructure to CNEN's technical teams such as the management of the vehicles used for transport to the field, supplying food and water, reimbursement of extra expenses, uniforms, etc.

3.3. Local supervisors and triage

For each venue, a group of local supervisors was nominated in a way that, at each shift, one person from this group was always at the venue. It was their responsibility to organize the work of the triage teams and to act as the interface between the team and the venue administration, the other security forces and the operational coordination.

The triage group worked together with the frontline officers from the national force in the access control at the venues. At all entry points, both for pedestrians or vehicles, the frontline officers in charge of the control of metal detector portals and X ray inspection machines also used PRDs (Fig. 2). They were the first line of detection.

At all gates, two members of the triage group from CNEN, using RIDs, were ready to act in case of an alarm from one of the PRDs. In the event of an alarm, the line or lines involved were stopped and the persons entering were directed, one by one and with an escort from the national force, to CNEN's triage group where the origin of the alarm was determined. This was the second line of detection.

FIG. 2. Frontline officer from the national force using a PRD at the entry point of one venue.

A third line of detection was also defined to be used in cases where the radionuclide was not one used for health treatment or medical examination, where neutrons were also detected or where the dose rate was greater than 100 μSv/h. In such cases, the person was to be taken to a reserved room and kept isolated; the MEST should be called for a more complete evaluation and the whole security system informed. Fortunately, during the games, no such cases occurred, so the third line of detection was not activated. The main activities for the triage group can be summarized as follows:

— Training security officers in the use of PRDs if they had not previously been trained;
— Surveying individuals, packages or sites where an alarm occurred;
— Identifying and classifying the type of radionuclide that caused the alarm: NORM, medical, industrial or nuclear;
— Categorizing the radioactive material due to its risk (IAEA categorization);
— Secondary inspection of the public at the checkpoints;
— Supporting the local anti-bomb squad officer before arrival of a technical support team.

3.4. MEST

In supporting the security forces during the Pan-American Games, the MEST, based at IRD, was responsible for the prompt and coordinated response to any event, both accidental and malevolent, with potential or actual radiological consequences to the population, environment or properties. The structure for the MEST was based on that already existing and established to respond to nuclear accidents and radiological emergencies. The basic MEST formation was two senior radiation protection experts acting as field and deputy field coordinators, two radiation detection officers and three experts on environmental assessment, internal and external dosimetry. For the games, four teams worked in shifts of 12/36 h.

Depending on the type of event, it was planned that the CNEN MEST would act in conjunction with the response groups from other institutions involved in the security actions planned. The roles and responsibilities of the MEST were:

— Supporting the bomb squad to identify and classify any radioactive material that caused an alarm: NORM, medical, industrial or nuclear;
— Categorizing radioactive material due to its risk (using the IAEA categorization);

— Assisting the bomb squad in handling a radiation dispersal device if necessary;
— Performing more sophisticated analysis to identify radioactive elements;
— Performing car borne or backpack surveys to localize radioactive material;
— Controlling operations involving a radiation exposure field;
— Using specific codes to assess the dose due to different pathways of exposure to radiation;
— Using near field codes for dispersion predictions and environmental impact;
— Recommending countermeasures on isolation of the area, sheltering and evacuation, etc.

In order to accomplish those responsibilities, the MEST had a set of appropriate equipment available which enabled it to respond quickly to locate and identify any potential hazards with the deployment of a field team. The main equipment used by the MEST was:

— Two portable HPGe systems with associated electronics and software;
— Three car borne gamma mapping pieces of equipment with large NaI(Tl) detectors;
— Two neutron search detectors;
— Five backpacks with gamma and neutron detectors with GPS capabilities;
— Five RIDs;
— PRDs;
— Individual protection equipment.

Besides that, the computational infrastructure existing at IRD could be used for the assessment of risks through the use of a set of models available. Two models from the National Atmospheric Release Advisory Centre/Lawrence Livermore National Laboratory (NARAC/LLNL), Livermore, California, USA, for the assessment of environmental consequences of releases, including explosions, had been made available by the US Department of Energy. The first one was a tri-dimensional model that uses meteorological data from the US National Oceanic and Atmospheric Administration (NOAA) for which access to the IXP site was granted to the MEST experts and the hot spot that uses a bi-dimensional Gaussian plume model with the meteorological data provided by the user. For dose assessment, the code SIEM, developed at IRD, could be used for the evaluation of doses from the dispersion of radionuclides both in urban and rural areas using dynamic models. Two other codes for internal and external dose assessment and one based on IAEA-TECDOC-1162 [2] with more simple calculations for various scenarios, also developed at IRD, were used.

Due to the distances and geographical situation, a second smaller group based at IEN, as a back up to MEST, was established and also worked 24 h shifts. This group was also in charge of eventually recovering to a safe and secure storage any nuclear and other radioactive materials that accidentally or intentionally could cause harm to the population, environment or property during the games.

3.5. Venue survey group

In order to guarantee the integrity of the venues, a complete survey was done by CNEN, and together with bomb squad groups, before their closure and the start of the full access control by the national force. This work started with the Pan-American Village on 24 July 2007, since that was the first venue to be occupied by the athletes, coaches and referees. For almost all other venues, the final survey was conducted in the last week before the start of the games. There was no fixed number of staff members allocated to this group at this phase and the number was, in fact, decided each time, depending on the total area to be surveyed. The equipment used by this group included RIDs, backpacks and car borne survey systems, depending on the established approach and the specific boundary conditions of the venue (Fig. 3).

3.6. Training and exercises group

Due to the specificities of this operation, a special training programme was established for each of the different groups involved. A group composed of

(a) (b)

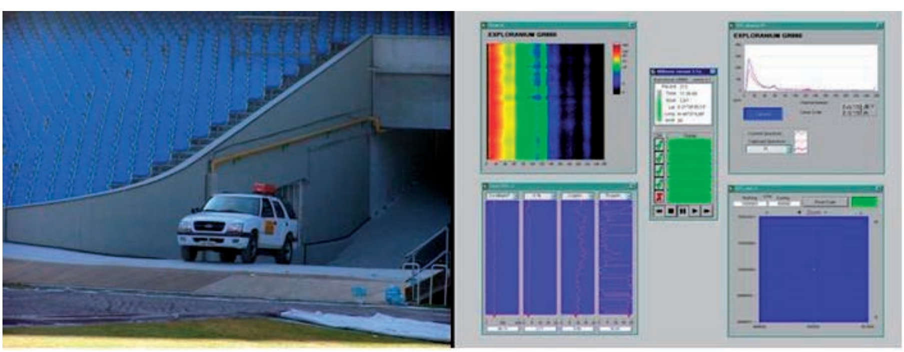

FIG. 3. (a) Car borne gamma survey system used at the Maracanã Stadium; and (b) a display example.

22 staff members, selected based on their previous experience, attended the train the trainers courses provided in conjunction with the IAEA, as already mentioned, and formed this group.

The group accomplished its mission and training was provided to:

— Six hundred frontline officers from the national force;
— One hundred and sixty bomb squad members from the federal police, civil police and national force;
— One hundred and twenty triage and local supervisor teams from CNEN;
— Twenty-eight MEST members from CNEN.

The training courses programme was composed of principles of radiological protection, instrumentation (PRDs, RIDs and backpacks), the concept of operations, specific procedures for each team and practical exercises. The courses were held simultaneously at IRD and IEN, for groups of 30 participants, with half of the total number being trained at each institution.

3.7. Additional actions

3.7.1. Establishment of preventive measures at the nuclear and radioactive installations and related to the transport of nuclear and radioactive materials

The nuclear and radioactive installations from the Rio de Janeiro State were informed about the realization of the Pan-American Games and asked to reinforce their security measures in order to minimize the risks of theft and sabotage of radiation sources or nuclear material and associated facilities. They were also asked to keep the transport of this type of material to the minimum possible. Those actions were coordinated by the Safeguards and Physical Protection Coordination (COSAP/CNEN) for nuclear installations and by the General Coordination for Medicine and Industry (CGMI/CNEN) for radioactive installations.

3.7.2. Certificates of medical treatment or examination involving radioactive compounds

All medical installations in the Rio de Janeiro State were requested by the CGMI/CNEN to supply a certificate to all patients submitted to treatments, or diagnostic examinations, using radioactive compounds from 1 July 2007 until the end of the games with specific instructions to the patients to carry the certificate with them if they entered any of the venues. It is important to note that presentation of the certificate did not grant the person the right to enter the venues without passing through the second line of detection in the event of an alarm. The objective of the certificate was, first of all, to inform the patients in advance that there was the possibility that they could trigger an alarm at the entry points and that they should identify themselves to a security officer.

3.7.3. Media communication

It was decided that all media communication related to the security of the games, including nuclear and radiological aspects, was exclusively under the control of SENASP. CNEN staff members were only to talk to the press upon receiving a specific request from SENASP.

4. RESULTS

4.1. Venue survey activities

As has already been stated, all competition and other relevant venues were surveyed before the beginning of the games. This work was very important, not only to guarantee that the venues were clear of any type of radiation sources introduced with a malevolent intention but also to provide data about the natural background variation at those venues. The analysis of those variations in advance, and its availability to the MEST, is a very important tool. A good example of this variation is shown in Fig. 4 where the results of the gamma dose rates measured with one RID in one of the buildings of the Pan-American Village, that was composed of 14 buildings with a total number of 1480 apartments, is presented. The existence of many peaks on those measurements is very clear.

The strategy used at this venue was that two members of the venue survey group, using one RID and one digital clock, were responsible for each building. The RID was set up to keep a log of all the readings with an interval of 2 s, and while the person with the RID was surveying the apartments the other one was only noting down the time at which the first was entering and leaving each apartment or compartment inside the building and generating a timetable. In this way, within 3 h, one building with ten floors was surveyed and, at the end, the data was downloaded from the RID to a portable computer and imported to a spreadsheet to generate a graphical view of the data. This graph was then verified by the coordinator of the group to check if there were any anomalous readings missed by the team. In the case shown in Fig. 4, although in this case it was reported by the teams during the survey, using the timetable to check the

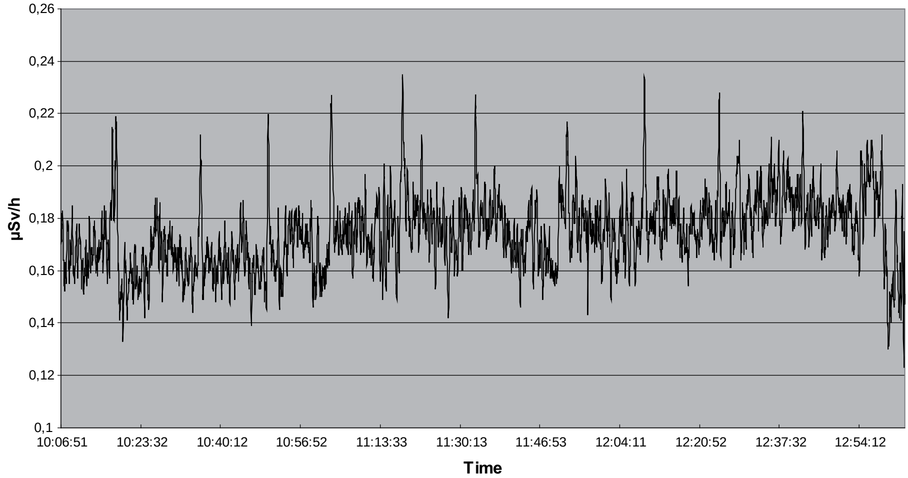

FIG. 4. Results of the survey of one of the buildings from the Pan-American Village.

position where the peaks were appearing, it was easy to see that they were at the stairs between the floors, mainly due to the amount of concrete used.

For large areas, such as the seats of a large arena shown in Fig. 5, the strategy used for the survey was quite different but the data analysis remained the same. In those cases, a larger number of persons, each one using one RID, were able to survey a large area at once while one controller was taking note of the position of each person, and the start and end time for each run. The timetable was then used as the input to another spreadsheet that was prepared to analyse the log and calculate the mean, standard deviation, and the maximum and minimum at each location. This spreadsheet was made available to the MEST.

For open areas and at the venue surroundings, both the backpacks and the car borne gamma mapping equipment were used. For those cases, the data were converted to a KML file and Google Earth was used for viewing the results as shown in Fig. 6.

4.2. Access control at venues

During the games, 42 PRD alarms were registered, 40 due to patients submitted to medical treatments, or diagnostic examinations using radioactive compounds and two false alarms. In 50% of the alarms, the person involved had a medical certificate, confirming that they were submitted to medical treatment

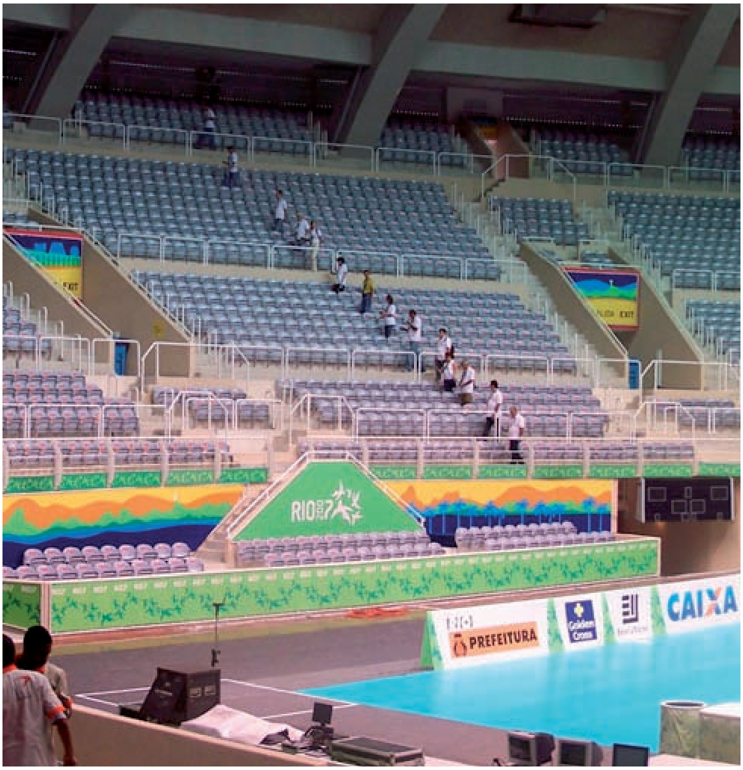

FIG. 5. Survey of the Maracanãzinho arena seats using a line of RIDs.

with radioactive compounds and, in all those cases, the radionuclide identification provided by the RID was in perfect agreement with the certificate.

MEST action was requested three times during the games. Investigation and technical procedures carried out in conjunction with security forces concluded that the presumed events were false alarms. During the whole period, MEST exercises were conducted, with the deployment of the mobile units to different venues and with the conduction of real measurements associated, in some cases, with tabletop exercises for the assessment group that stayed at the base. The outcomes from those exercises were used for reviewing MEST procedures.

FIG. 6. Survey of the RIOCENTRO surrounding area using the car borne gamma mapping system (image courtesy of Google).

5. CONCLUSIONS

Nuclear and radiological security was only included in the overall security actions seven months before the games. It caused several unnecessary problems to CNEN in fulfilling its mission that was accomplished only due to the dedication, effort and professionalism of its experts and personnel, and the prompt support of the IAEA. Nuclear and radiological security should participate in the security process of a major event right from the beginning of the planning of the overall security, and should have a very well defined and clear position in the security organizational plan.

A total of 250 CNEN staff members participated in the nuclear and radiological security actions. During the competition period alone, 210 participants undertook a total of 20 375 staff hours of work and this does not take into account the time spent in planning, surveying and training before the start of the games. For the second line of detection for access control, 126 staff members were involved, with a total of 12 200 staff hours; this required a significant logistics effort that could have been avoided had security forces undertaken this task. For the Pan-American Games, the time available was too short to train the security force officials in the use and interpretation of the results of RIDs, and for that reason it was decided to use CNEN staff for that. If security forces had been used, it would only have been necessary to have one or two experts from CNEN at each venue acting as a third line for really suspicious events.

Innocent alarms due to the use of radioactive substances for medical treatment and examinations are very likely to occur but focus should be kept on the main goal, which is the detection of criminal use of radioactive material.

Logistics deserve special attention as the control and deployment of field teams demands a lot of coordination efforts. The issue of credentials for large events is also a problem if they are not available in advance due to restrictions of access imposed on the team members. Communication is essential to make actions easier; provisions for tactical and strategic communication should be made in advance and adequate training provided.

ACKNOWLEDGEMENTS

The authors would like to acknowledge the outstanding work performed by CNEN staff members with dedication, effort and professionalism that is reported in this paper. We thank the prompt support of the IAEA, its staff and, in addition, the other experts that participated in the missions and training courses. We also thank the other Brazilian institutions involved in the security actions, especially SENASP, and the US Department of Energy for the cooperation and provision of equipment.

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VERIFICATION OF DECLARED CONTENT IN THE TRANSPORT OF RADIOACTIVE MATERIAL

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Abstract

The illicit trafficking of nuclear and other radioactive materials during legal transport (in the presence of a licence and other certified documents) across borders by substituting the quantity or quality of the declared materials poses a serious problem for customs authorities at border checkpoints. To prevent such cases of illicit trafficking, the parameters of the declared nuclear or other radioactive materials must be compared to the actual measured parameters of the material being transported. The paper describes procedures and methods for carrying out a customs control of nuclear and other radioactive materials during their legal transport across borders.

1. INTRODUCTION

The IAEA pays significant attention to the prevention of illegal movement of nuclear materials, radioactive substances and radioactive waste across borders. Currently, significant progress has been made in the field of creation of means and the procedures for their use, which focus on the suppression and detention of nuclear and other radioactive materials that are illegally transported across border checkpoints.

Adjusting national systems to meet the norms of the IAEA will lead to the maintenance of effective control of nuclear and other radioactive materials. This is especially true for countries that are signatory to the Code of Conduct on the Safety and Security of Radioactive Sources [1] and have concluded agreements on guarantees. Nevertheless, control can be lost for various reasons.

There is a threat of smuggling of nuclear and other radioactive materials during lawful transport of such materials (in the presence of a licence and other certified documents) by substitution of their quantity and/or qualities. The means and procedures now realized at borders according to the recommendations of the IAEA are unsuitable for the purposes of suppression of smuggling of radioactive materials during legal transport across borders (export, import, transit) as they cannot check the quantitative and qualitative characteristics of these materials.

Now that new technologies are available for controlling the legal transport of radioactive materials, customs authorities in the majority of countries check the accompanying documents at border checkpoints for radioactive materials for observance of interdictions and the restrictions imposed by national acts, and also the quantity of the transport packing sets in which these materials are transported.

There is no mechanism for checking the radiation characteristics of the nuclear and other radioactive materials given in the customs declaration. For the transport of radioactive substances across borders, it is the specific radioactive nuclide (or a mixture of radioactive nuclides) and activity that must be ascertained, while for nuclear materials percentage enrichment of the isotope ^{235}U and ^{239}P must be measured.

This is connected first of all to the absence of means of radiation control adapted for the conditions of customs control, allowing an inspection of conformity between the declared radiation characteristics of the radioactive materials in the customs declaration and the concrete data of actual measurements.

The absence of such a mechanism creates a real threat of illicit trafficking of nuclear and other radioactive materials within the scope of legal deliveries by substitution of the quantitative and qualitative characteristics of these materials.

The data on international smuggling of nuclear and other radioactive materials during their legal transport across borders show that there are cases of detection of such smuggling using only operative data rather than by revealing a discrepancy in the radiation parameters of radioactive materials by means of radiation control.

To intercept the smuggling of nuclear and other radioactive materials during legal transport across borders, other technologies and means than those currently applied are necessary. It should be noted that 90% of all radioactive materials moved across borders emit gamma radiation. Furthermore, all potentially dangerous sources of ionizing radiation used in nuclear weapons are also sources of gamma radiation.

2. STRUCTURE

The procedure for checking the declared contents during the transport of nuclear and other radioactive materials includes the following steps:

— Strategic estimation of the threat of illicit transport of nuclear and other radioactive materials during their legal transport across borders, and also a way of minimizing the threat of illegal circulation of these materials, according to national legislation and a choice of location for controls and a controlling structure;
— Control of the existence of permissive documents for transport of nuclear and other radioactive materials;
— Control of the maintenance of safe conditions of transport of radioactive materials;
— Control of the radioactive contents of transport packing sets to increase the efficiency of actions of customs services at borders interacting with all national competent bodies responsible for suppression of illegal circulation of radioactive materials;
— Choice of methods, devices and procedures for the control of nuclear and other radioactive materials during their legal transport across borders;
— Preparation of users;
— Maintenance of the established infrastructure and activity.

In essence, these stages define the structure of this paper.

Actions or measures which should be undertaken in cases where examination has revealed a discrepancy in the contents during the transport of radioactive materials are considered in Ref. [2].

3. COUNTERACTION OF THREATS

Reducing the potential threats connected with the transport of nuclear and other radioactive materials across borders is the major aim of the competent structures that regulate these materials.

With a view to counteracting the threats of illegal trafficking of nuclear and other radioactive materials across borders, a complex set of standard actions must be followed, including:

— Development and equipping of competent structures with specialized spectrometer complexes (as a rule, gamma spectrometer complexes) for the detection of nuclear and other radioactive materials adapted for the conditions for controlling at borders which would allow experts to carry out a control of the declared parameters of these materials without unpacking the material and with an accuracy sufficient for the purposes of the control;

— Training of qualified personnel from the competent structures, capable of carrying out controls and identifying the declared parameters of the nuclear and other radioactive materials at their export, import and transit within the limits of the general customs procedures and technologies;
— Organization of interaction and cooperation with law enforcement and competent structures responsible for achieving the regulation of the circulation of nuclear and other radioactive materials;
— Controlling with a view to detecting nuclear and radioactive materials in goods of increased risk imported into the country, and in goods of increased risk exported from the country.

4. BASIC PROCEDURES AND TECHNOLOGIES FOR CARRYING OUT CUSTOMS CONTROL OF NUCLEAR AND OTHER RADIOACTIVE MATERIALS AT THEIR TRANSPORT ACROSS BORDERS

When controlling the transport of nuclear and other radioactive materials across borders, officials from the competent structures should:

— Check the documents and data about nuclear and other radioactive materials;
— Examine the packaging of the nuclear and other radioactive materials without opening protective containers.

At inspections of the packaging, officials from the competent structures should:

— Weigh the packages with nuclear and other radioactive materials;
— Measure the radiation on the surface of the package and at a distance of 1 m from the surface using a dose rate meter. The level of superficial pollution with alpha and beta radiating radioactive nuclides should also be determined;
— Identify, using specialized spectrometer equipment, nuclear and other radioactive materials, and define the quantitative and qualitative characteristics of these materials without opening the protective container (the name of the nuclear and other radioactive materials, isotope structure, activity, etc.).

If, while carrying out an examination of the attributes a discrepancy between the measured parameters of the radioactive materials and those declared in the customs declaration and the licence of adjusting body to the data is identified, the specified materials are sent for examination to the specialized organization accredited in the field of carrying out examinations, with a view to preparing a criminal case. The procedure for carrying out a customs control of nuclear and other radioactive materials during their legal transport across borders is illustrated in Fig. 1.

It should be emphasized that the presented procedure for controlling nuclear and other radioactive materials by competent structures is in addition to those procedures and recommendations outlined in IAEA TECDOCs 1311, 1312 and 1313 [2–4], Code of Conduct on the Safety and Security of Radioactive Sources [1], Guidance on the Import and Export of Radioactive Sources [5] and others.

5. METHODS OF EXAMINING THE RADIOACTIVE CONTENTS OF TRANSPORT CONTAINERS

One of the basic elements of the general procedure for examining nuclear and other radioactive materials transported across borders is an examination of the factual conformity of the data declared in documents with the actual characteristics of the material. The factual examination of nuclear and other radioactive materials which are in transport containers should include the following basic operations which are carried out without opening the container:

— Identification of the radioactive material and definition of its radiation characteristics: activity for radioactive materials; isotope structure for nuclear materials;
— Additional factual examinations including measuring the level of superficial radioactive pollution by alpha and beta radiating radioactive nuclides; weighing and X raying the packages with radioactive material.

5.1. Identification of nuclear and other radioactive materials, and definition of their radiation characteristics: recommended methods and technologies

As mentioned above, a very real threat of smuggling of radioactive materials is posed by their substitution (e.g. transport of nuclear material disguised as radioactive material) and also by the transport of radioactive materials with dubiously specified characteristics.

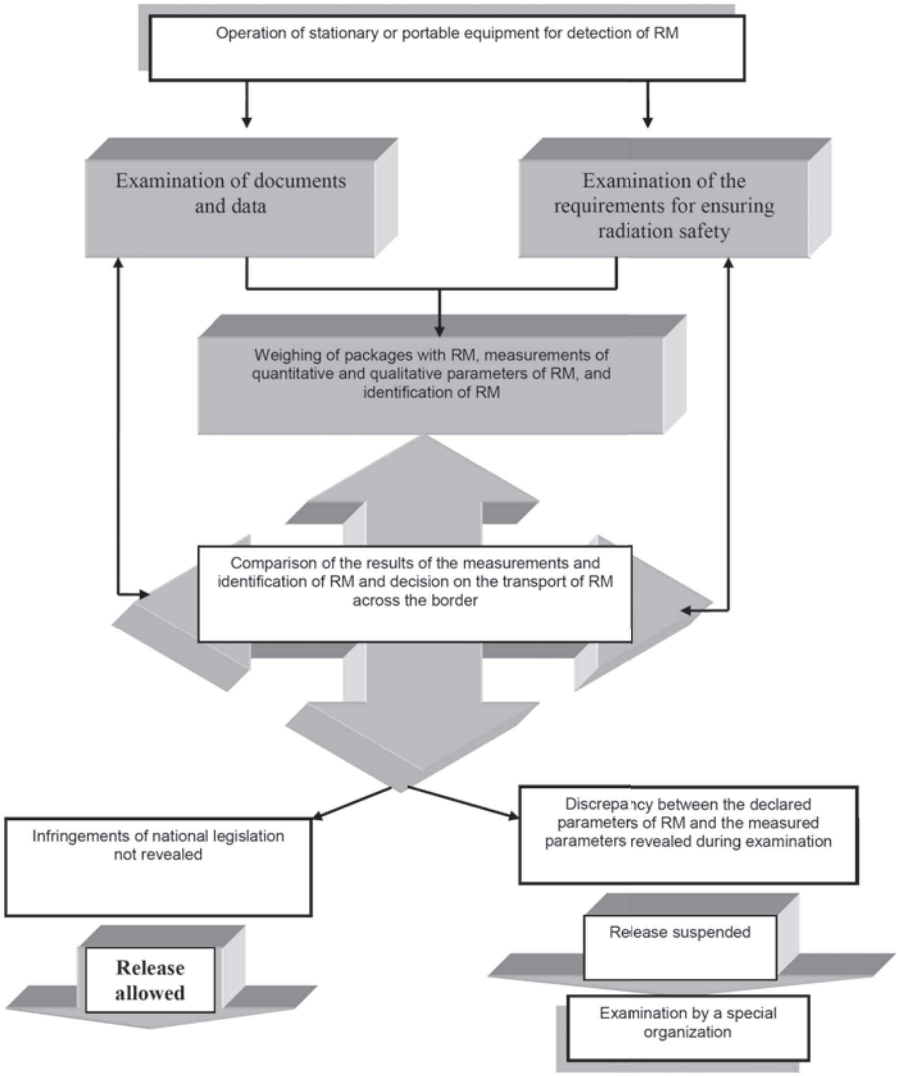

FIG. 1. Procedure for carrying out a customs control of nuclear and other radioactive materials during their legal transport across borders.

Taking into account the fact that, due to nuclear and radiation safety concerns, opening protective containers during transport is forbidden, an examination of the actual quantitative and qualitative characteristics of radioactive materials (isotope structure, activity, degree of enrichment) in field conditions poses a considerable challenge.

The current examination methods of nuclear and radioactive materials [3] comprise identification by means of handheld instruments for the detection and identification of radionuclides.

The current limitations of such equipment (incomplete library of radionuclides, presence of significant weakening and change of spectral characteristics, impossibility of use of specialized software, etc.) do not allow a full control of the legal transport of nuclear and other radioactive materials.

For customs authorities to solve problems associated with the control of legal transport of nuclear and other radioactive materials, the most comprehensible method is the spectrometric control of these materials without opening the protective containers in which the given materials are transported.

The main goals of spectrometric control are:

— Identification of the radioisotope declared for transport (identification using as far as possible a detailed library of gamma spectra);
— Definition of radionuclide activity both in the shielding containers and without them, the quantitative characteristics of which are declared in the customs declaration in activity units (use of a database of transport packing sets);
— Confirmation of the absence of undeclared sources of gamma radiation in the container in cases of legal transport of alpha, beta or neutron radiation sources;
— Definition of the degree of enrichment (according to ^{235}U) of the uranium declared for transport;
— Definition of isotope structure of nuclear materials (e.g. of plutonium).

5.2. Technical support of spectrometric measurements

Technical support of spectrometric measurements assumes the presence of the following basic components:

— Gamma spectrometer with a detection device;
— Software;
— The technique for the performance of measurements.

5.3. Gamma spectrometers

Table 1 outlines the recommended features of gamma spectrometers.

TABLE 1. RECOMMENDED FEATURES OF GAMMA SPECTROMETERS

Quantity name	Value
A range of registrable energies (keV)	(50–3) × 10^3
Energy resolution:	
of a semiconductor spectrometer, no more than (%)	0.2
of a scintillation spectrometer, no more than (%)	8
Efficacy of a registration according to the line 1332 keV (^{60}Co):	
of a semiconductor spectrometer, not less than (%)	15
of a scintillation spectrometer, not less than (%)	40
Limit of a supposed basic inaccuracy of measurement of activity in punctual geometry, no more than (%)	±10
Continuous running time (h):	
all-mains	Not less than 24
from accumulators	Not less than 8
Spectrum analyser channels amount, not less than:	
of a semiconductor spectrometer	8192
of a scintillation spectrometer	1024
Spectrometer weight (kg), not more than	10
Climatic conditions of operation of a spectrometer:	
temperature (°C)	–20–40
humidity (%)	90
Mean lifetime (a)	10

5.4. Software scale spectrometers

The software of the gamma spectrometers along with special programmes of management and processing of gamma spectra should contain specialized databases:

— A library of radionuclides;
— A library with characteristics of shielding materials, shielding containers and transport packing sets (Fig. 2).

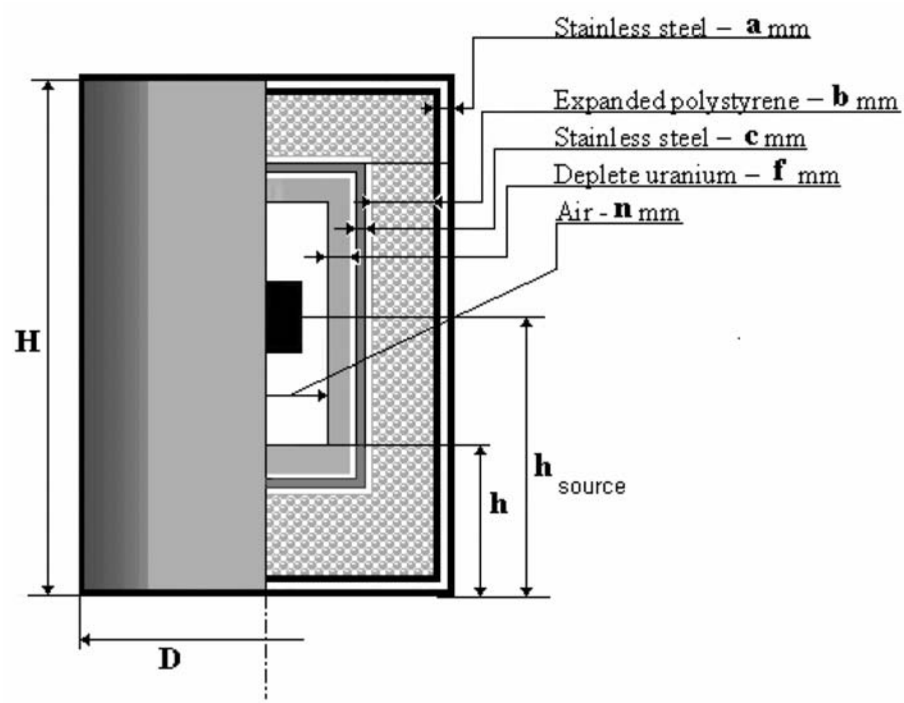

FIG. 2. Example of the possible construction of a transport container.

6. REQUIRED ORGANIZATION AND INFRASTRUCTURE

The basic components of the organization and infrastructure are:

— Formation of technology for customs control and creation of a corresponding normative–legal base;
— Creation, within the customs service, of divisions complete with trained experts; organization of training of the personnel; equipping with means;
— Interaction of the customs service with regulatory and other State bodies (interdepartmental interaction);
— Technical support for performance of measurements.

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MEGAPORTS ANTWERP
Detection of nuclear smuggling

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Abstract

Nuclear inspections at seaports are a relatively new phenomenon. In the Port of Antwerp, a nuclear inspection system is being installed and is already partly in use. It uses plastic scintillators as a primary portal. This has an important effect on the way nuclear inspections are performed. The paper presents the results of a radiological study with a plastic scintillator in the Port of Antwerp in 2006. This is followed by a general overview of the Megaports inspections in Antwerp during 2007. Furthermore, a tool is discussed that can facilitate the task of recognizing a source smuggled in naturally occurring radioactive material (NORM). In general, nuclear inspections should be designed to make NORM identification reliable, easy and straightforward. This way the focus of the inspections shifts towards the few exceptional or suspect alarms that occur during inspections, rather than to the identification of an alarm as being caused by NORM. Of course, smuggling with NORM as a shielding material has to be taken into account.

1. INTRODUCTION

1.1. The Megaports Initiative

The Megaports Initiative is a worldwide effort to prevent nuclear smuggling in container traffic. The US Government sponsors the worldwide installation of nuclear detection equipment in ports. The Belgian Government agreed to such an installation in the Port of Antwerp. Other governments are joining the programme or have an independent programme for nuclear inspections at their borders. Expectations are that, in the coming years, nuclear inspections at land borders (seaports, airports, land crossings, etc.) will become a standard feature.

1.2. Nuclear inspections in a port

An important aspect of nuclear inspections in a port is to find a balance between an adequate inspection of the container traffic and the resulting economic impact on the port. Therefore, a general approach has been designed in the Megaports Initiative. It consists of three phases:

- In a primary inspection, all containers are inspected by radiation portals. A radioactive load will cause an alarm on the portal and customs will react to this. The primary reaction is to block the container and to collect manifest data. If the container contains naturally occurring radioactive material (NORM), it will be released if the radiation profile corresponds to a homogeneous load;
- Suspect containers are further investigated during a secondary inspection. Customs officers will use handheld equipment to further characterize the radioactive material in the container. In most cases, containers will be released after this inspection because of confirmation of the NORM nature of the contents of the container;
- If no logical and legally acceptible explanation is found, local government officials are warned. A tertiary inspection is performed by radiation experts, mostly consisting of reviewing the available data and performing a physical inspection of the container. In Belgium, the authorized agency is FANC and, in most cases, co-workers of NuTeC will perform the task of a radiation expert. Customs has no authority in this phase.

1.3. The effect of detector type on inspections

When designing a nuclear inspection system for borders, an important feature is the choice between the different possible detectors for primary inspection portals. Due to recent technical developments, border authorities can choose between three types of detectors: a plastic scintillator, a sodium iodide scintillator or a high purity germanium diode. All types have their advantages and shortcomings. The choice of detectors as a primary portal has a big effect on the way the nuclear inspections are performed.

The installation in Antwerp uses plastic scintillators and helium tubes in the primary radiation portals. Therefore, we focus on the use of plastic scintillators as a primary inspection detector for gamma radiation. The main advantage of the plastic scintillators is their high sensitivity for gamma radiation. The main disadvantage of plastic scintillators is their limited ability to distinguish between NORM and artificial sources of radiation. In other words, you are never sure what caused the alarm in the first place. In the following, we discuss some possible approaches to circumvent this problem.

2. RADIOLOGICAL SURVEY OF CONTAINERIZED TRANSPORT WITH A PLASTIC SCINTILLATOR PORTAL

In 2006, NuTeC performed a survey of the container traffic in the Port of Antwerp. These measurements were used to estimate the effect of nuclear inspections on the container traffic in the port. Furthermore, it provided a first glimpse of the kind of radioactive materials shipped through the Port of Antwerp. A more detail description of this survey is available in Dutch [1].

2.1. Set-up and approach

The survey was performed at the scan site of Antwerp customs. At this site, containers are scanned for smuggling. The containers are selected from all over the port based on risk analyses and at random. In Fig. 1, the set-up for the survey is presented. It consisted of two radiation portals and one X ray scan facility or scan tunnel (two linear accelerators). The portal in front of the scan installation consisted of four 25 L plastic scintillators without energy windowing. The other portal consisted of two 25 L plastic scintillators with energy windowing.

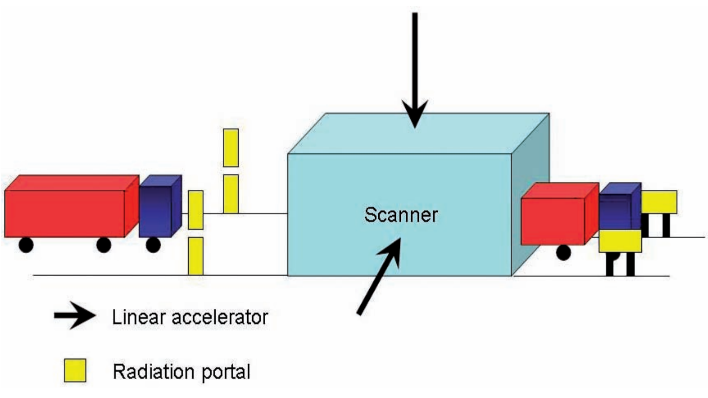

FIG. 1. Set-up for the radiological survey at the scan site of Belgian customs at the right bank in Antwerp.

We used the three phase approach mentioned in the introduction. In this particular case, the primary inspection also consisted of taking a scan image.

2.2. Results and discussion

2.2.1. Primary inspections

During the primary inspections, 624 of a total of 9145 containers caused an alarm; this corresponds to an alarm rate of 6.8%. In the following, we discuss our approach in the assessment of the alarms and the type of materials encountered.

Portals with plastic scintillators give an alarm when a radioactive load passes through them. The information provided by the software connected to the portal consists of: (1) a sigma level (a rough estimate of the radiation intensity); and (2) the radiation profile of the container (this indicates where the source of the radiation is located). This information helps us to estimate whether the radiation dose is within legal limits and whether we have a container with NORM or not. Typically, a NORM alarm corresponds to the whole container being the source of the radiation rather than a small part, though releasing a container based on this information alone is not advisable.

The energy windowing present in one of the portals did not prove to be a useful tool to distinguish between NORM and artificial sources. This is problably due to the low activity present in most containers.

During the survey, we therefore used two extra sources of information:

(a) Manifest information: this is to verify whether the radiation could have a natural source. Most NORM materials are known and therefore comparing manifest information with portal information is a reliable technique for recognizing NORM;
(b) Scan image: if shielding were present, this image would indicate this. Containers with NORM have very typical scan images in most cases and are thus identified. Comparing the scan image and the portal information is another possible technique for recognizing NORM. Without manifest information, this technique has the disadvantage that contamination of the whole load of a container is not recognized because it has the same radiation profile if no energy windowing is possible.

In practice, we combined the three sources of information, thus enabling us to make an acceptable decision on releasing or blocking a container.

The materials causing alarms can be quite diverse; the reason for the radioactive nature of these materials is almost always the same: NORM. Only one case of ^{60}Co contamination was detected in a period of six months. A list of frequently detected materials is given in Table 1.

2.2.2. Secondary inspections

To distinguish between NORM, contaminated materials, commercial radioactive sources or nuclear smuggling, a measurement with handheld equipment is another possible technique. During a secondary inspection, measurements are performed in order to: (1) distinguish between heterogeneous and homogeneous radioactive loads; (2) ascertain the maximum dose rate; and (3) identify the radionuclides present (Table 2).

An important factor is the ability of the handheld equipment to detect all the radioisotopes present in the container. Measurements with the available handheld equipment was not the most obvious choice. This was due to the fact that, in most cases, the handheld gamma spectroscopy equipment did not detect radionuclides present in the containers within a reasonable amount of time (1–2 min). This is due to the relatively small detector used (NaI(Tl) 2 in. × 2 in. or 5.08 cm × 5.08 cm) and the low activity of most commercial NORM.

TABLE 1. TYPES OF MATERIALS MEASURED AND THE PERCENTAGE OF ALARMS CAUSED BY EACH

Manifest information	Alarms (%)
Ceramics	38
Stone	16
Biological materials	7
CRT (televisions)	6
Ores	5
Kitty litter	2
TENORM	3
Glass fibre and glass	4
Chemical products	5
General descriptions and rare alarms	13
Unknown	2

TABLE 2. MATERIALS ENCOUNTERED DURING SECONDARY INSPECTIONS TOGETHER WITH MAXIMUM MEASURED DOSE RATE AND ALARM PEAK AT THE PORTAL

Manifest information	Dose rate (μSv/h)	Alarm peak (sigma)
Ceramic tiles	0.09	67
Stones	0.06	11
Tiles	0.15	81
Ceramic	0.15	74
Pottery and iron bars	0.05	2
Mica and sport clothing	0.035	4
Granite stones	0.12	17
Natural stones	0.05	6
Gres tableware	0.12	64
Dinner set	0.14	90
Potassium chlorate	0.32	161
Citric acid salts	0.35	191
Christmas articles	0.06	19
Manufactured articles	0.12	39
Zirconium sand	0.6	276

During the survey, very few inspections with handheld equipment were needed due to the presence of the X ray scanner and the availability of manifest information. In almost all cases, alarms could be sufficiently explained without a secondary inspection. In 37 cases, measurements with handheld equipment were performed (0.4% of all containers passing the portal).

All measured activities were below exemption levels for radioactive materials as stated in Belgian and European legislation [2]. Therefore, no containers were blocked during the survey period.

2.2.3. Tertiary inspections

Two containers were opened for physical inspection in a tertiary inspection. In one case, some concern was raised about the activity concentration of a potassium salt in the container. Measurements proved that the activity concentration was below legal levels.

A more interesting case was a container shipping musical instruments. The investigation of the scan image and a secondary inspection with handheld equipment did not reveal the nature of the source, but enabled us to pinpoint the origin of the radiation. During the physical inspection, steel temple bells were discovered as being the source of the radiation. Further measurements revealed that the steel was contaminated with ^{60}Co. Because of the relatively low activity concentration, the temple bells were not confiscated.

2.3. Conclusions

Techniques and working protocols for nuclear inspections should be selected so that a distinction between NORM, contaminated materials, radioactive sources and nuclear smuggling is easy and straightforward. Decisions based only on the radiation profile of the alarm are not reliable. The second most important source of information is the manifest information. This information should be easily accessible and reliable. Another technique is the combination of a radiation portal and an X ray scanner. Combining all three information sources is the ideal, but not always feasible in practice. This is due to the logistical efforts needed to scan containers. The use of handheld equipment seems reasonable but has important limitations.

3. MEGAPORTS ANTWERP: WHAT DID WE LEARN?

Nuclear inspections in Antwerp started in February 2007 at the right bank. During the first months, only two container terminals were inspected. Currently, five container terminals are permanently inspected at the right bank. Antwerp's left bank will follow by the end of 2007.

3.1. Primary inspections

The primary inspections are performed by portals containing four 5 L plastic scintillators and eight ^{3}He tubes. The main difference between our survey and the Megaports inspections in Antwerp is the lower alarm rate in the latter. This is problably due to the smaller volume of the plastic scintillators used and the less favourable distance between the portals at the container terminals.

The data for the period between February 2007 and October 2007:

— Alarm rate: 1.5%;
— 16 009 alarms and 1 099 677 occupancies;

— 117 alarms per day and 7653 occupancies per day in the period September to October (five terminals on-line);
— The types of materials identified are the same as mentioned in the survey above.

This vast amount of data gave us the oppurtunity to develop a new tool for the inspections in the Port of Antwerp. All alarm data were used to investigate whether the (maximum) sigma level and the type of NORM are correlated. For some materials, the sigma value is distributed in an almost Gaussian way around an average. This information was used to identify inspection limits for these materials. In this way, unnecessary secondary inspections of NORM containers are avoided. Of course, this method is limited by the reliability of the manifest information. Due to the sensitive nature of this topic, we cannot go into further detail.

3.2. Secondary inspections

Inspections with handheld equipment are very rarely used, for the following reasons:

— Low confidence in the standard NaI detectors in handheld equipment (see also Section 2.2.2);
— The more reliable Ge detectors present are heavy and impractical for performing measurements on trucks;
— Antwerp customs has a long experience in using scanners. It has both a fixed and a mobile scanner for import and export containers.

In general, the secondary inspection at this point consists mainly of taking a scan image of the container. Measurements with a handheld Ge detector are performed in two cases: (1) if the scan does not sufficiently clarify the alarm; and (2) if it is not certain that radiation levels meet legal exemption levels.

3.3. Tertiary inspections

The tertiary inspections in Antwerp show a remarkable resemblance to the ones performed in the Port of Rotterdam during a pilot project between Dutch customs and the US Government [3].

Containers are selected for tertiary inspections for various reasons:

— Suspect alarms: these are, in general, alarms caused by atypical materials, alarms with high peak values or a heterogeneous alarm profile, and neutron–gamma alarms;
— Doubts about the activity concentrations meeting legal exemption levels;
— In some cases, we just try to find an explanation for the alarm. For instance, an alarm on plastic flowers proved to be caused by NORM gravel. This gravel was used to mimic earth around the plastic flowers.

In three cases, the FANC was notified including:

(a) Two containers with ^{137}Cs contaminated blueberries. The activity concentration was below European Union exemption levels for food contaminated after the Chernobyl accident [4]. The containers were released;
(b) A load of ^{60}Co contaminated steel above exemption levels. The steel was transported to a radioactive waste disposal plant in Belgium.

3.4. Conclusions

The use of plastic scintillators for nuclear inspections in ports gives rise to many radiation alarms. These alarms can be described as a nuisance because, in almost all cases, the alarm is caused by NORM. These alarms in no way pose a threat to public health and State security. Efforts are made to avoid unnecessary secondary and tertiary inspections, but in the end these are unavoidable.

The ideal primary inspection portal would recognize NORM and only cause an alert if nuclear materials other than NORM are present or suspected to be present, or the activity present in the container is above legal exemption levels. Another important characteristic is a short inspection time.

ACKNOWLEDGEMENTS

The authors would like to thank Belgian Customs and Excise for their support, in particular T. Peeters, V. Claerhout and H. Van Cauwenberghe. All the data described in this paper could not have been collected without the help of the customs officers in Antwerp performing nuclear inspections and scanning containers day in, day out. Furthermore, we would like to thank all our US colleagues working on the Megaports Initiative. Finally, we would like to thank FANC for their confidence and support.

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ESTABLISHMENT OF A CONTROL AND EXCHANGE OF INFORMATION SYSTEM ON RADIOACTIVELY CONTAMINATED SHIPMENTS OR SHIPMENTS CONTAINING RADIOACTIVE SOURCES IN THE REGION

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Abstract

A significant threat from illicit trafficking of nuclear and other radioactive materials exists in Croatia considering the recent past of the region and the lengths of the Croatian borders. The IAEA and the US Department of Energy recognized Croatia as being part of the Romania–Croatia–Poland illicit trafficking conduit; several actions have been undertaken in resolving these issues.

The first regional meeting on scrap metal transport control and exchange of information on radioactively contaminated shipments or shipments containing radioactive sources was organized by Croatia. Specific goals of the first meeting were to reach an agreement on the reporting and exchange of information on detected radioactive material between regional radiation protection regulatory authorities, to improve and harmonize scrap material control methods and response to radioactive material or radioactive contamination detection; to determine the obligations of the country of origin of the radioactive material or contaminated scrap, to determine the possible routes by which radioactive sources are introduced into the scrap metal cycle and the possibility of its contamination, all in order to minimize the proliferation of radioactive material and consequently minimize the possibility of its use for terrorist aims. The meeting was attended by representatives of Bosnia and Herzegovina, Croatia, Macedonia, Montenegro, Slovenia and Serbia. The supporting document used during the meeting was the Recommendations on Monitoring and Response Procedures for Radioactive Scrap Metal prepared by a group of experts and published by the United Nations Economic Commission for Europe (UNECE).

All the participants endorsed such a need and expressed their willingness for the future cooperation of the countries in the region in preventing illicit trafficking or inadvertent movement of radioactive material. The participants agreed to encourage mutual collaboration in border control between customs and other border authorities.

Croatia has 189 border crossing points staffed by border police, of which 118 are permanent international crossings and 14 are seasonal sea border crossing points with a customs service. Presently, radioactive goods detection equipment has been installed at only one of Croatia's border crossing points and a limited number of pagers have been distributed to customs officers at some border crossings.

In the next two years, stationary portal monitors will be installed at 14 main border crossings. The majority of border crossings cannot, however, be covered with such stationary equipment but will be controlled using mobile portal detection systems on a random basis or in response to acquired intelligence. The equipment in question will be procured through the European Union PHARE programme.

The capacity of Croatian authorities to detect and monitor illicit trafficking conduits on the territory of Croatia would thus be enhanced in the near future.

Another significant action taken was the organization of the first regional meeting on scrap metal transport control and exchange of information on radioactively contaminated shipments or shipments containing radioactive sources that was held in Zagreb on 21–22 March 2007. The meeting was attended by representatives of Bosnia and Herzegovina, Croatia, The Former Yugoslav Republic of Macedonia, Montenegro, Slovenia and Serbia, and aimed at establishing permanent regional collaboration and exchange of information on illicit trafficking of radioactive material, where this term covers all radioactive materials, including nuclear materials.

A specific goal of the first meeting was to reach an agreement on reporting and exchange of information on detected radioactive material between regional radiation protection regulatory authorities, to improve and harmonize scrap material control methods, and the response to radioactive material or contamination; to determine obligations of the material country of origin, and any potential contamination sources, possible routes by which radioactive sources are introduced into the scrap metal cycle and possibility of its contamination, all in order to minimize proliferation of radioactive material and consequently to minimize its use for terrorist aims.

The supporting document used during the meeting was the Recommendations on Monitoring and Response Procedures for Radioactive Scrap Metal prepared by a group of experts and published by the UNECE.

All the participants endorsed such a need and expressed willingness for future cooperation of the countries in the region in preventing illicit trafficking or inadvertent movement of radioactive material.

The participants agreed to encourage collaboration in border control between customs and other border authorities. Such collaboration should result in sharing of equipment for radioactive material control and detection.

The participating countries agreed to undertake the following activities for improvement and harmonization of scrap metal control methods, and responses on the detection of radioactive material or contamination:

— Set up a register of scrap yards, scrap melting plants and processing facilities;
— Prepare an analysis of other activities involving risks of illicit trafficking of radioactive material;
— Direct scrap metal to designated border crossings and determine transport corridors by national legislation, unless they are already regulated by national laws and regulations.

All participants agreed that the country of origin must assume responsibility for a shipment for which increased radioactivity is determined and enable it to be returned with minimum administrative formalities.

Representatives of the countries in the region shall encourage industry, scrap metal yards and melting plants to collaborate and exchange information and warnings about possible problems with individual scrap metal shipments.

All participants underlined the need for informing customs officials about radiation basics and for organizing training in the use of instruments and methods for the detection of radioactive material. It has been concluded that cooperation with the IAEA should be requested. Training should be organized in one of the national languages of the region.

All the participants concluded that the initiated cooperation should result in a regional international agreement on collaboration on the subject issue.

IAEA-CN-154/026

THE LEGAL AND TECHNICAL BACKGROUND OF PREVENTION, DETECTION AND RESPONSE MEASURES AGAINST ILLICIT TRAFFICKING IN HUNGARY

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Abstract

The present paper provides an overview of the legal and technical measures in place in Hungary that aim to prevent, detect and respond to incidents of illicit trafficking in nuclear materials. The Hungarian Atomic Energy Authority (HAEA) is responsible for the central registry of radioactive material. In the interest of promoting international cooperation in relation to the illicit trafficking of such material, one of the priorities of the HAEA is to provide data for the Illicit Trafficking Database of the IAEA.

1. PREVENTION

A strict and accurate accounting system (central and local registries) for radioactive sources is among the prerequisites for the safe use of nuclear energy. The Hungarian Atomic Energy Authority (HAEA) is responsible for the central registry of radioactive materials (open and sealed sources), which is supported by the computerized database of the central registry and the provision of authenticated register books for the local registries (owners and users of radioactive materials).

The central registry provides the possibility of determining the current inventory of each licensee and the current inventory of each nuclide at any time. Other information for sealed radioactive sources in the database include the owner, the person responsible for the local registry and the physical location of the source. Additionally, the licensees shall maintain a local registry for all radioactive materials falling under the scope of their licences by a computer program provided by the HAEA free of charge. The local registry is maintained in such a way that the quantity, type, activity, storage location and application (usage) of all radioactive materials falling under the scope of the licence could also be determined at any time.

Implementation of the central registry related provisions of Council Directive 2003/122/EURATOM of 22 December 2003 on the control of high activity sealed radioactive sources and orphan sources (HASS) required the modification of the related national legislation. In the Ministerial Decree of 33/2004 (VI. 28) BM on the local and central accountancy system for radioactive materials, the HAEA introduced the requirement for annual inventory taking as well. A licensee performs an inventory of the radioactive materials falling under the scope of its licence at least once in each calendar year in such a way that the time between two inventories does not exceed 14 months, and/or upon the request of the HAEA, and definitely upon termination of the practice (closing inventory).

The central registry contains details of about 28 000 sealed sources altogether, out of which about 7000 are actually in use in Hungary. The database includes approximately half a million items, which represent all the radioactive material produced in or imported to Hungary since 1960.

During the implementation of the HASS directive, the HAEA did not change the entry level of the central registry for radioactive materials and — instead of the A1/100 value in the HASS — the exemption activities and exemption activity concentrations (with few exceptions, which are basically nuclear fuel and shielding, packing, ballast and counterweights made of depleted uranium) were used for this purpose. In this way, practically all of the radioactive sources are kept track of in a rather tight system.

The control of radioactive sources has been improved by an increased inspection effort in recent years (Fig. 1). In the future, the HAEA plans to conduct an inspection of even the smallest licensee at least once every five years. The maintenance of local registries is inspected by the HAEA on the site of the licensee, according to an annual inspection plan based on the evaluation of the inventories, practices and regular reports of the licensees.

The National Police Headquarters (NPH), the National Security Office (NSO), the General Directorate for National Emergency Management, and the Frédéric Joliot-Curie National Research Institute for Radiobiology and Radiation Hygiene (NRIRR) may request any type of information recorded in the central registry.

2. DETECTION OF RADIOACTIVE MATERIALS AT BORDERS

At the border checkpoints of Hungary, the incoming goods traffic is monitored by portal monitors (Fig. 2). Additionally, customs officers are

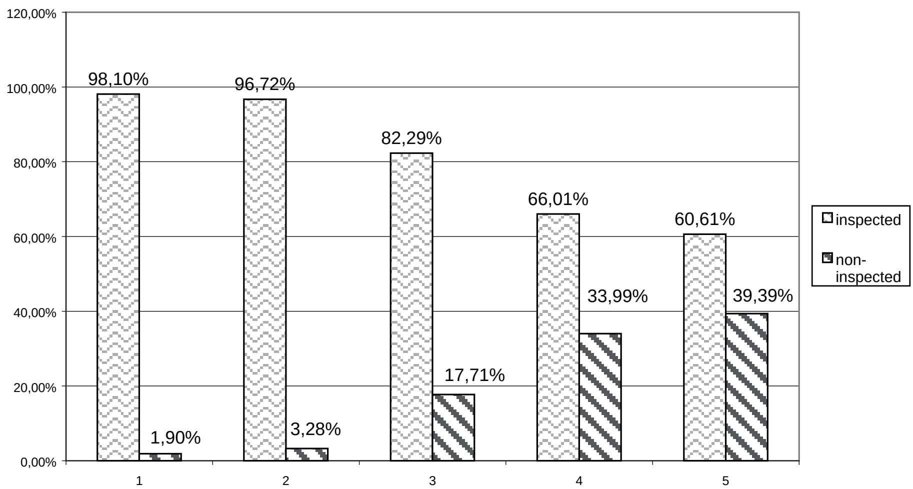

FIG. 1. Percentage of inspections by CoC categories (sealed sources).

equipped with handheld survey meters. Some of the scrap yards in the country are equipped with portal monitors as well.

At present, 26 portal monitors are located at the borders between Hungary and those countries which will not join the Schengen Agreement in 2008. Control will be terminated at the Austrian, Slovakian and Slovenian borders, while Romania as a member of the European Union will be under

FIG. 2. Portal monitors at border checkpoints.

relieved monitoring. Of our international airports, only Ferihegy 1 owns a fixed portal monitor that is used for controlling incoming stocks.

Every customs office is responsible for the operation of detector gates in its own territory where such gates are installed.

Detector instruments are not installed for outgoing traffic. In cases giving rise to suspicion, the customs office makes measurements by hand. The future purpose of the customs office is to locate detectors and pedestrian monitors in every passenger incoming direction, including at all airports.

In the case of water passages, fixed portal monitors cannot be installed at a river entrance cross-section. A solution could be to trans-ship stock from float-on ships to lorries that could then pass through the detector situated in the port. The newly built load–traffic border port at Mohacs could serve for this purpose.

3. RESPONSE

The response measures regarding found and seized radioactive and nuclear materials, and transport and storage of radioactively contaminated materials or nuclear materials are regulated by Gov. Decree 17/1996 (I.31.) Korm. This decree prescribes the tasks and duties of the different organizations involved from the reporting of detection through the accurate identification, to the storage of radioactive materials (Fig. 3).

If it can be assumed that an object which has been found or been seized in the course of other proceedings is a radioactive or nuclear material or has been contaminated by such materials, the police, competent border police or customs authority body must prevent individuals from approaching the area.

The Customs and Finance Guard does not possess legitimate detective administrative action powers against crimes concerning the abuse of radioactive materials. Thus, if there is reasonable suspicion, only urgent detective actions can be undertaken. The police should be informed in parallel as they have the legitimate official function and competency in such cases.

In addition to notifying its own responsible units, the notified Main Duty Office of National Police Headquarters (ORFK/NPH) will also report the incident to the duty offices of the following organs:

- Ministry of Health (in order to have a radiohygiene expert dispatched to the scene from NRIRR);
- NSO of Hungary;
- HAEA;

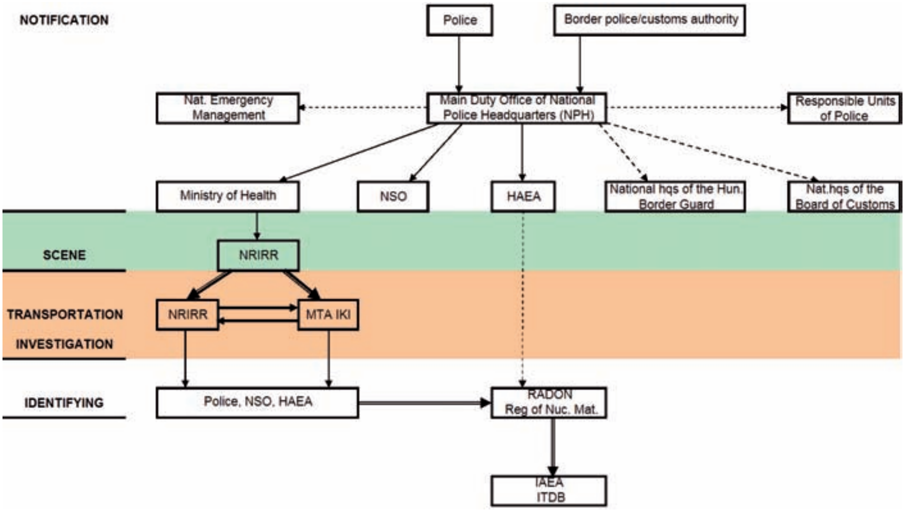

FIG. 3. Alarm chain in case of illicit trafficking.

— National headquarters of the Hungarian Border Guard (in the event of an incident near the border or at a border crossing point);
— National headquarters of the National Board of Customs and Excise (in the event of materials or customs goods entering from abroad);
— In practice, the General Directorate for National Emergency Management.

If the radiohygiene expert determines that it is probable that the found or seized material is radioactive, then a preliminary inventory will be taken, determining the quantity of the material, and an inspection made of the packaging, and the materials collected if necessary. If the material can be transported by motor vehicle, it will be taken to the Frédéric Joliot-Curie NRIRR to the storage site designated for this purpose. If the material cannot be transported by motor vehicle, the radiohygiene expert will contact the Institute of Isotopes of the Hungarian Academy of Sciences (MTA IKI) which will transport the material to its own site as soon as possible.

If the found or seized material is classified as nuclear material, NRIRR must immediately inform MTA IKI, in the interest of agreeing measurement methods. On the business day following completion of the radiohygiene tests, MTA IKI will transport the material to its own site. In the event that the material is serving as criminal evidence, the regulations governing the handling and recording of objects seized in criminal proceedings will be observed when taking samples of the material, as well as during the testing and storing of such.

In the interests of identifying the material, it shall be clarified whether or not the radioactive material or nuclear material is registered in the central accounting system maintained by the HAEA, or whether a foreign owner of the material can be determined. Radioactive or nuclear material which is not registered will be entered into the central accounting system.

In the interest of promoting international cooperation in relation to the illegal trafficking of such materials, the HAEA shall, with the exception of State secrets, provide data for the Illicit Trafficking Database established by the IAEA.

The HAEA is making a comprehensive survey of the technical background of the different organizations, and plans to prepare a nationwide exercise for practising and checking the legal background in 2008.

IAEA-CN-154/043

WAYS OF ILLICIT TRAFFICKING PREVENTION IN TAJIKISTAN

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Abstract

The radiation protection system created in Tajikistan is the instrument for preventing nuclear and radiological terrorism, but parts of the radiation protection infrastructure are not developed due to socioeconomic conditions, which were affected by civil war (1992–1997), such as accounting and control of sources of ionizing radiation, physical security of sources, means for detection and analysis of orphan sources and public information which is useful and helpful to protect the nuclear and radioactive materials against theft, important equipment against sabotage, and to prevent illegal trafficking of such materials. The paper provides an overview of the current situation in Tajikistan, a discussion of the steps involved in the manufacture of nuclear weapons, and conditions conducive to the illicit trafficking of nuclear material. Other issues, including the accounting and control of radioactive material, the prevention of such trafficking and areas for improvement are also addressed.

1. OVERVIEW OF THE SITUATION IN TAJIKISTAN

The radiation protection system created in Tajikistan is the instrument for preventing nuclear and radiological terrorism, but parts of the radiation protection infrastructure are not developed due to socioeconomic conditions, which were affected by civil war (1992–1997), such as accounting and control of sources of ionizing radiation, physical security of sources, means for detection and analysis of orphan sources and public information which is useful and helpful to protect the nuclear and radioactive materials against theft, important equipment against sabotage, and to prevent illegal trafficking of such materials. In 2001, Tajikistan became a Member State of the IAEA and the established regulatory authority has been functioning for just four years. There are currently four laws and six regulations for ensuring radiation safety in Tajikistan and new regulations are in the process of development. Radiation safety in Tajikistan is mainly based on the Law on Radiation Safety (2003) and on the Law on Utilization of Atomic Energy (2004). Unfortunately, in Tajikistan, because of a limited national budget, there are no appropriate or accredited technical services. There is only one functioning laboratory (Republican Chemical and Radiometric Laboratory) which performs measurements and radiation measurement and laboratory analysis of material. Metrological attestation of devices and sources of this laboratory was carried out by the laboratory of technique measuring ‘KSAVO’ (Central Asian military division) in 1992. After that period, no metrological attestation was carried out. Some devices were delivered under an IAEA project but it is not enough to cover the needs of the country.

One of the most disturbing problems nowadays is terrorism using nuclear materials. Terrorists are also able to use so-called dirty bombs, that is, products of nuclear fission or highly radioactive materials that are detonated with a common explosive. As is well known, for the creation of a nuclear weapon high enriched ^{235}U or plutonium, which must contain more than 90% ^{239}Pu are needed and, of course, use of highly developed technologies. That is why many terrorist groups may choose simple methods of synthesis of nuclear materials. To achieve this goal, they try all available ways to obtain access to: (a) nuclear materials; (b) equipment; (c) experts and specialists; (d) know-how. In order to prevent the activity of terrorist groups, the international community is creating systems of prevention and control in the nuclear field. One of the main factors to achieve this goal is establishing effective national systems of defence and control.

One of the main problems of regulatory authority in Tajikistan is the absence of radiation detectors at the border with neighbouring countries and in the airports to prevent illicit trafficking. Thus, in 2004, 2006 and 2007, the representatives of the Ministry of Defence arrested a number of persons at the border of Tajikistan with Afghanistan who attempted to sell radioactive sources (beryllium sources of fast neutrons and ^{137}Cs sources). May be there were more cases of illicit trafficking due to the absence of these detectors. Now the NRSA tries to do its best to be in compliance with security requirements. From 2006, there is a joint project of regulatory authority (NRSA) and Sandia National Laboratories (operated for the US Department of Energy). For the successful implementation of this project, several sets of equipment were delivered to the country on behalf of the Global Search and Secure Program to Tajikistan. Training on performing site searches utilizing the delivered equipment and technique was performed in the orphan source training. The specialists of NRSA, industrial and medical organizations which involve the use of ionizing radiation, the Committee of Emergency Situations and Civil Defence of the Republic of Tajikistan (CES CD RT) and other organizations were trained by US specialists. In addition, under this project, NRSA specialists together with specialists from the Republican Chemical and Radiometric Laboratory of CES CD carry out searches of orphan sources in all territories of Tajikistan. Searches in the north and west of Tajikistan have already been finished. The search team also carries out monitoring of former Soviet military bases. After the collapse of the Soviet Union, a lot of orphan sources remained in the territory. Radioactive sources were found at former Soviet military bases and were transported for disposal to the national waste disposal site. The searches are continuing. Now specialists will monitor the east and south of Tajikistan. More than 200 hundred orphan sources have already been found. They belonged to enterprises which are bankrupt or no longer operational. It is now necessary to find sponsors to arrange the transport of these sources to the national waste disposal site in order to prevent unauthorized access or damage to, and loss, theft or unauthorized transfer of, radioactive sources, so as to reduce the likelihood of accidental harmful exposure to such sources or the malicious use of such sources to cause harm to individuals, society or the environment.

2. STEPS IN THE MANUFACTURE OF NUCLEAR WEAPONS

Nuclear materials and radioactive sources have become attractive for terrorists in view of the fact that while having significant damaging force they can ensure mass destruction and bring with them moral, economic and psychological damage.

It is well known that nuclear weapons are manufactured using uranium and plutonium. Schematically, one can imagine manufacturing of a nuclear charge from uranium using the scheme in Fig. 1.

It is clear that manufacturing nuclear weapons is a complicated technological process. Not all countries are capable of implementing this process. Therefore, terrorists are very much interested in radioactive sources on the basis of ^{137}Cs, ^{60}Co, Am and others.

A source of radioactivity must be accessible and it must be used in many facilities. The regime of security and safekeeping differs in various countries.

In general, the problem of control over illicit trafficking of nuclear and radioactive materials is presented in Fig. 2.

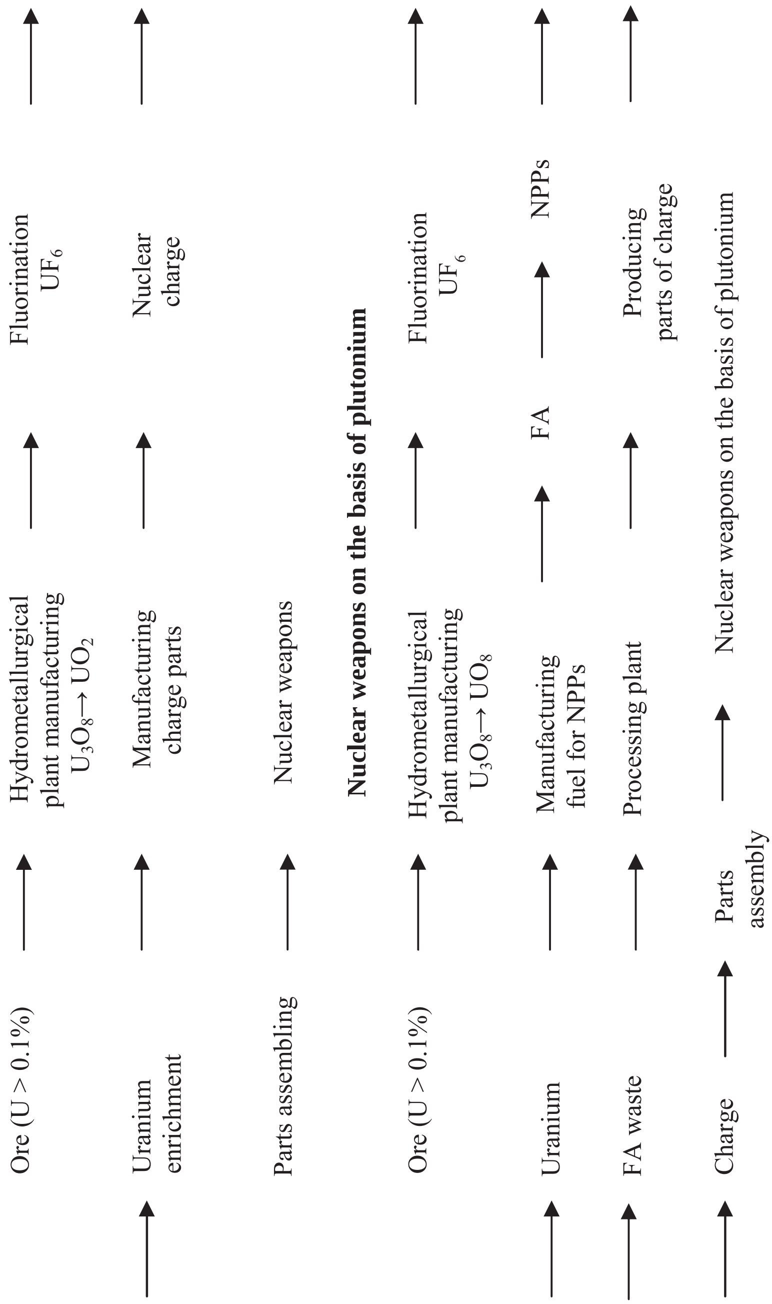

FIG. 1. Manufacturing a nuclear charge from uranium.

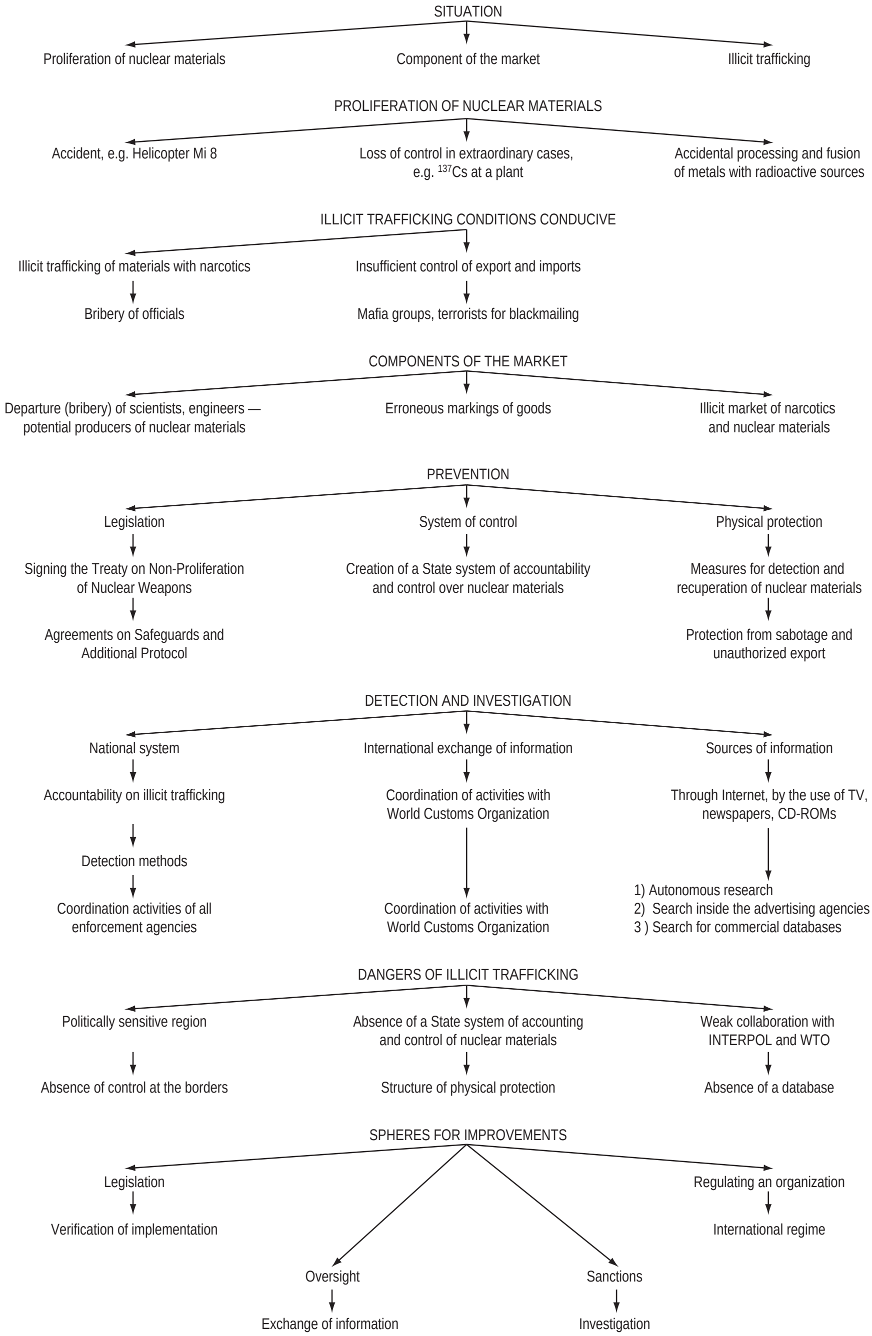

FIG. 2. The difficulty of controlling illicit trafficking of nuclear and radioactive material is illustrated.

3. ACCOUNTING AND CONTROL OF RADIOACTIVE MATERIALS

Under the control of agencies of the State sanitary service are 839 facilities using different sources of ionizing radiation, including industrial: 187; medical (radiological sections and rooms): 329; and open and closed sources of ionizing radiation utilized in scientific and research institutions: 423.

Taking stock of all the sources of ionizing radiation is performed by using the receipt–expenses registers according to the form approved by the basic sanitary rules (OSP 72/87). Inventory taking of the ionizing sources and their description is conducted according to the loss of their functional activities, and later they are delivered to the centre for burial of radioactive wastes (city of Faisabad). The radiological group of the centre of the State sanitary–epidemiological supervision is conducting a retrospective accounting of the sources of ionizing radiation from 1961. The most urgent among the problems of accounting and control for the sources is the existence of 22 tail dumps remaining from the past and containing radioactive elements.

4. ORPHAN RADIOACTIVE SOURCES IN TAJIKISTAN

After the events of 1992–1993, the situation became complicated due to the ‘loss’ of radioactive IRS (Table 1):

- In 1997, in the territory of Tjikgidromet, four RITEG type highly radioactive orphan radioisotopes were found (the four RITEGs have been delivered to the RCBRS for safekeeping);
- Tajikgas being the ordering facility, there were 11 various radioisotope instruments and five of them are being searched for;

TABLE 1. REGISTERING IRS IN THE REGIONS OF TAJIKISTAN

Region	Total IRS	Unsealed sources among them
City of Dushanbe	276	4
Sogdia region	537	0
Khatlon region	67	0
R.R. Subordination	206	0
Total in Tajikistan	1076	4

— Radioactive IRSs from some military units were detected and delivered for burial;
— In 2004, an attempt at selling radioactive sources (beryllium source of fast neutrons) was precluded;
— An attempt at selling a plutonium–beryllium source was suppressed in 2006;
— In 2007, another attempt at selling three sources was also thwarted.

5. ORPHAN RADIOACTIVE SOURCES IN TAJIKISTAN

The following are considered to be unaccounted for (according to the information from MES and CD):

— Level gauges — 4 pieces;
— Measuring device for gas leakage — 2 pieces.

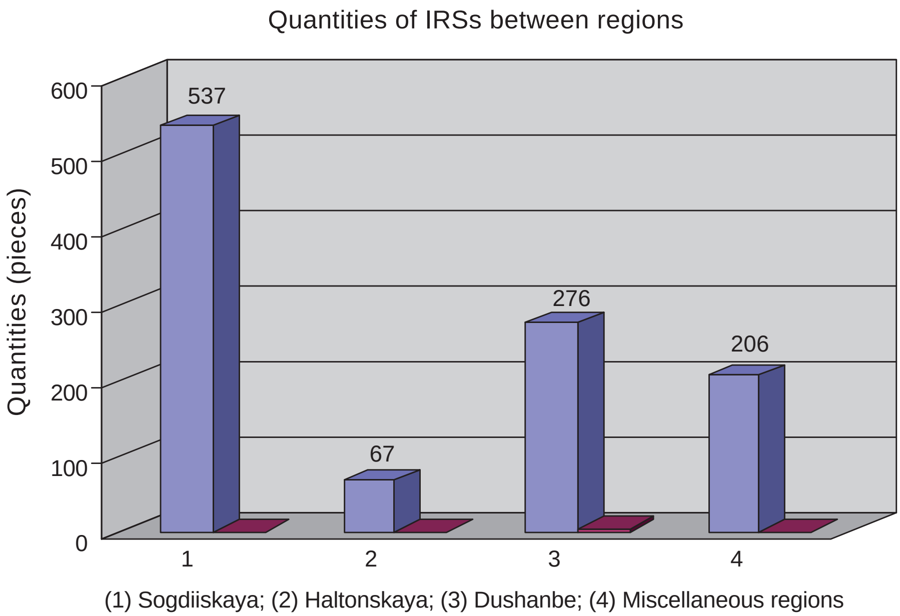

FIG. 3. Distribution of IRSs between regions of Tajikistan: (1) Sogdiiskaya; (2) Haltonskaya; (3) Dushanbe; (4) miscellaneous regions.

The following are considered to be probably lost:

— Calibration equipment — 4 pieces;
— Radioisotope device M-2 — 2 pieces;
— Level gauge — 1 piece;
— Densitometer — 1 piece;
— Radioisotope device — 1 piece;
— Measuring device for gas leakage — 2 pieces.

6. INVENTORY TAKING

From the results of the inventory, it was established that RT has more than 150 organizations, the activities of which are connected with the use of IRS. Those are basically closed sources of ionizing radiation (^{127}Cs, ^{60}Co, ^{241}Am, Cd, Se, Fe and other isotopes). At present, there are approximately 1100 IRSs in the organizations and plants. A databank on IRS is being created.

DISCUSSION

SESSION 4: Establishing Capabilities to Detect Illicit Trafficking — I

S. ELEGBA (Nigeria): (1) Is the USA scanning procedure restricted to consignments coming into the USA or does it include consignments leaving the country? (2) Is the Russian Federation effort directed only at false declaration rather than at concealment of radioactive material, as the film tried to portray?

B. BREDEHOFT (United States of America): (1) Currently, at our borders, we are screening only incoming cargo. We acknowledge that this is short sighted in terms of global architecture and we need to increase the capacity to screen outgoing cargo too.

N.E. KRAVCHENKO (Russian Federation): (2) The technology is directed at checking radiation characteristics of nuclear and radioactive material declared on customs forms for real material being transported in containers. This technology has already been used in the Russian Federation for ten years.

J. NIEWODNICZAŃSKI (Poland): (1) Would you tell us more about the 'active' methods of examination that you plan to add to your 'passive' ones? (2) Are you planning to use neutron generators?

B. BREDEHOFT (United States of America): We are currently investigating the appropriate technologies and operational protocols for non-intrusive inspection (NII) techniques — gamma and also neutron radiography. We desire a system capable of identifying high Z material that may be used as shielding. Dual energy systems are being analysed as a promising solution. (2) We are also looking at neutron interrogation, but safety concerns dominate this approach.

A.J. AL KHATIBEH (Qatar): In the USA, several government departments, for example, Energy (DOE), Defense (DOD) and State (DOS) — work on nuclear terrorism prevention. What is the rationale behind having many authorities conducting the same work? Will the Department of Homeland Security (DHS) take over all these responsibilities?

B. BREDEHOFT (United States of America): The DHS's Domestic Nuclear Detection Office (DNDO) was established to coordinate US Government efforts and to consolidate a comprehensive strategy for global nuclear detection architecture. The DOE, DOD and DOS maintain their responsibilities for implementation of the legacy programmes. Each of these agencies has a unique area of expertise though overlap in responsibilities does occur. Their involvement is also driven by their ability to get legislative authority and funding from the US Congress.

A.J. AL KHATIBEH (Qatar): You have proposed regional cooperation. We extend our hand to participate from now.

R. GUYONNET (France): With regard to DNDO programmes, do you think that comprehensive scanning is a realistic goal — especially for maritime containers — considering commercial activities?

B. BREDEHOFT (United States of America): The key to comprehensive radiation scanning is the deployment of an adequate capacity (sufficient scanning systems) and operational procedures to keep the time spent on each container at a manageable level. Currently, we are comprehensively scanning inbound US containers and managing the operational burden by selection of alarm threshold — setting it as low as possible, taking into account the amount of secondary screening required by the setting. The use of spectroscopic portals in primary screening is a promising approach to combine primary and secondary screening into a shorter period.

A.S. SARHAL (Afghanistan): (1) Currently, radioactive material is detected before entering Russian Federation territory. What happens to it afterwards? (2) How can customs in the least developed countries be aided in this regard?

N.E. KRAVCHENKO (Russian Federation): (1) The work is twofold: (a) with the help of specialized organizations (ROSATOM), transferring the detected material to a certified laboratory for identification and registration so as to be under State control; and (b) initiating legal prosecution of the smuggler, using the technical evidence gained in the specialized laboratory.

R. ARLT (IAEA): (2) In the afternoon, I shall present the model used at the IAEA to help developing countries in this area, so we can come back to this question then.

SESSION 4: Establishing Capabilities to Detect Illicit Trafficking — II

V. FRIEDRICH (IAEA): The Croatian presentation gave an excellent example of multilateral cooperation between countries in a subregion, making the handling of detected orphan radioactive sources easier. Are these countries planning to bring it to agreement at a formal government level? Does it include sharing border monitoring equipment?

D. KUBELKA (Croatia): Yes, we have established cooperation and will try to install and share the same detection equipment for border control.

M. MAYOROV (IAEA): Concerning the Megaport programme, there is unsubstantiated data about ‘innocent’ neutron alarms associated with a ‘ship effect’ caused by either spallation of cosmic rays or additional moderation being transported through the detection zone of a radiation portal monitor (RPM). Have you detected such events?

P. FIAS (Belgium): Yes, cosmic and statistical — in total, 10–20 false neutron alarms.

M. MAYOROV (IAEA): From the list of equipment you showed us, I did not see handheld neutron monitors, only IRDs. How do you verify neutron alarms caused by spallation effect?

P. FIAS (Belgium): I look at the alarm file details and if we are not sure, we have a neutron detector to use on the container. In the few cases where we did that, the container was empty.

E.K. SOKOVA (United States of America): Please provide us with details about an illicit trafficking case involving both nuclear material and drugs in Tajikistan.

I.M. MIRSAIDOV (Tajikistan): In 2004, the Narcotics Control Agency arrested a person who was suspected of possessing drugs. He was found to be carrying drugs and also some unknown material, which — after laboratory analysis — was revealed to be a plutonium–beryllium source.

R. PALGAN (Paraguay): (1) Is the Belgian customs service the sole Government inspecting agency in the Megaport when there is an alarm? (2) If a shipment is found to contain radioactive material, does the Belgium customs agency take custody of the container or pass it on to another responsible agency?

P. FIAS (Belgium): (1) No, also the Federal Agency for Nuclear Control (FANC). (2) FANC uses certified experts and laboratories to examine the material, and takes responsibility.

RESPONSE TO THE DETECTION OF CRIMINAL OR UNAUTHORIZED MOVEMENT OF RADIOACTIVE MATERIAL

(Session 5)

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IAEA-CN-154/035

NUCLEAR FORENSICS
From specialized analytical measurements to a fully developed discipline in science

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Abstract

Nuclear forensic science aims at providing clues on nuclear or other radioactive material involved in illicit incidents. A considerable number of cases of illicit trafficking have been reported to the IAEA Illicit Trafficking Database, underlining the need for analytical and interpretation capabilities as well as for close international collaboration. Credible nuclear forensics can only be achieved if all evidence and case history are preserved and made available for data interpretation and source attribution. Hence, nuclear forensics investigations have to start at the 'crime scene'. As a consequence, a comprehensive response plan is required, clearly describing the responsibilities of the authorities involved and the role of the individual actors. Full nuclear forensics capabilities are only available in a few specialized laboratories. The Institute for Transuranium Elements (ITU) has established collaboration schemes with European Union member States and also provides nuclear forensics support to other countries that request it. This nuclear forensics support was tested by a number of the new European Union member States, when seized material was subject to joint analyses using the analytical infrastructure at ITU. Nuclear forensics remains a discipline challenging the capabilities of the analysts involved in the case investigations. Information on the origin of the nuclear material is inherent to the samples. Reading and understanding this information has, to a large extent, been established and appropriate laboratory protocols have been developed, validated and tested. Further research activities focus on the application of classical forensic methods to contaminated evidence. Emphasis was given to the two most prominent forensic techniques: taking of fingerprints and DNA analysis. In addition to the conceptual and operational developments, appropriate training has been provided to the authorities involved. The experience gained in joint nuclear forensic analysis of material seized in European Union member States is discussed, as well as recent advances in adapting classical forensic techniques for radioactively contaminated pieces of evidence.

1. INTRODUCTION

The first seizures of nuclear or other radioactive material were reported in 1991 in Switzerland and Italy. In subsequent years, numerous incidents involving radioactive or nuclear material were reported from Germany, the Czech Republic, Hungary and other central European countries. Apart from the need for determining the nature of the material, the authorities expressed interest in learning more about the intended use of the seized material, about its origin and about its potential trafficking route. As a consequence, nuclear measurement laboratories and research institutes were confronted with the need for analysis of these materials and for data interpretation. The analysis, however, needed to go well beyond the established safeguards analysis. Similarly, the data interpretation included new aspects such as hints on the mode of production and on the origin of the material. A new branch of science was born: 'nuclear forensics'. Nuclear forensics relies on the fact that certain measurable parameters in a sample are characteristic for the given material, for the source material it was prepared from and for the process used for its transformation. Using these characteristic parameters, one can draw conclusions on the intended use and on the possible origin of the material. The first step, however, consists of the identification of those parameters that are determined by the fabrication process or by the starting material, as only these parameters will provide useful information. Initially, data interpretation was essentially based on the know-how and expertise of knowledgeable individuals, and on information available in the open literature. In the mid-1990s, the laboratories involved in these nuclear forensic investigations started cooperating on an international level, particularly in the Nuclear Smuggling International Technical Working Group (ITWG). The analytical approach became more and more systematic, and new methodologies were developed and implemented. Model calculations (e.g. burnup calculations using codes such as SCALE or ORIGEN) were used for the determination of the mode of production of plutonium. A nuclear materials database was set up in a bilateral collaboration between the Bochvar Institute in Moscow and ITU in Karlsruhe. This database serves to guide the analysis and for attribution of materials.

The actual casework on seized samples clearly showed that nuclear forensics is an essential part of the response to illicit trafficking. Sustainable success in combating illicit trafficking can best be achieved if the origin of the material is identified and measures for prevention of future thefts or diversions are implemented. Credible nuclear forensics, however, relies on the preservation of evidence, on high quality measurements and on the availability of reference data or comparison samples. Thus, nuclear forensics laboratories are to be involved in the response process.

2. NUCLEAR FORENSICS METHODOLOGY — SHAPING A SYSTEMATIC APPROACH

Nuclear material is generally of anthropogenic origin, i.e. the result of a production process. The nature of this production process is reflected in the elemental and isotopic composition of the material as well as in its microscopic and macroscopic appearance. All of these parameters can be determined using appropriate analytical techniques. Some parameters can be combined to a 'nuclear fingerprint', i.e. they are characteristic for the mode of production of the material. Hence, they may provide a clue as to the origin of the material. With the first seizures of nuclear material, the analytical laboratories had to use an ad hoc approach for investigating the individual cases. In the years 1992–1994 (i.e. in a period of three years), some 20 seizures had to be investigated, i.e. under considerable time pressure and with significant public attention. As a consequence, established analytical techniques from the nuclear safeguards area were applied and complemented with some material science investigations. Data interpretation was essentially based on the know-how and expertise of knowledgeable individuals, and on information available in the open literature. Profiting from the development work which encompassed and followed the casework, a more systematic approach was implemented. The scheme which is followed today reflects the prioritization of characteristic parameters and allows the efficient arrival at nuclear forensic conclusions.

The scheme shown in Fig. 1 is to be understood as a guideline. The actual analytical scheme may differ from case to case and its execution will depend on the findings. The measurement data of each step are, wherever possible, compared against reference information.

3. REFERENCE INFORMATION FOR INTERPRETATION AND ATTRIBUTION

The data and information obtained through nuclear forensic analysis may be grouped into two categories: endogenic and exogenic information. Endogenic information is normally self-explaining. The age of the material is a direct result of measurements and straightforward calculations. In addition, the intended use of the material (commercial power reactor, nuclear weapons) can normally be concluded from the data as such. Exogenic information requires empiric data, archive material or a historical database (Fig. 2).

Information on nuclear material has been compiled in a number of databases throughout the world. However, due to commercial sensitivity or for national security reasons, the data in these databases is not openly available.

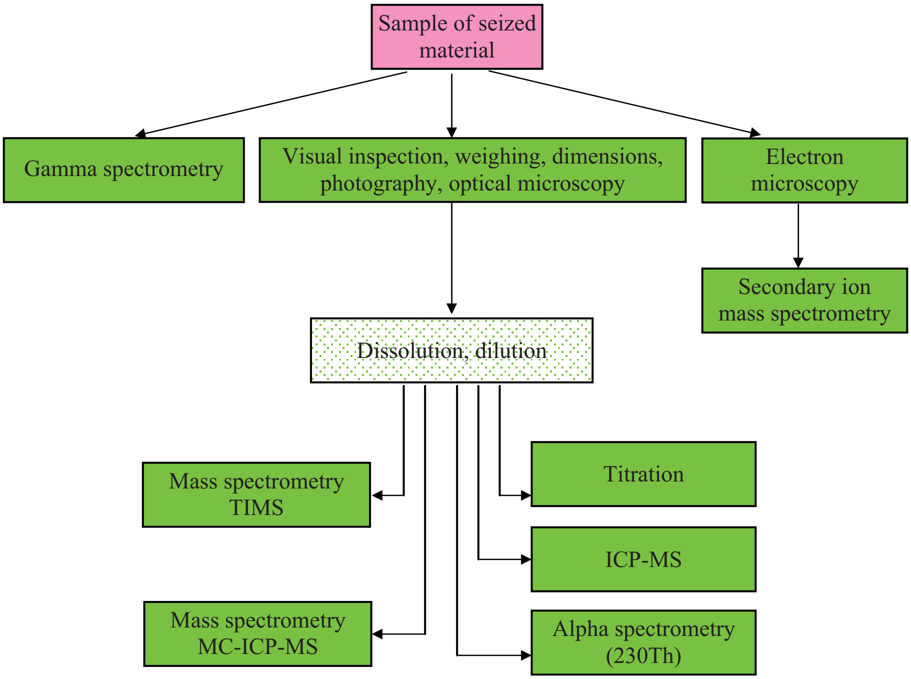

FIG. 1. Generic analysis scheme for nuclear forensic investigations.

ITU and the Bochvar Institute in Moscow jointly established a database on nuclear materials with a focus on nuclear fuels [1–3]. This database has recently been complemented by an electronic literature archive on non-conventional fuels [4]. Once the production batch or the reactor type have been identified, the last legal owner can be identified. In the absence of reference data, model calculations may be a useful tool for identifying the mode of production of a given nuclear material. Using the isotopic composition of a plutonium sample, one can, for instance, determine in what type of reactor the plutonium was generated. The IAEA maintains an Illicit Trafficking Database (ITDB) in which information on the seizure and on the material are stored. This allows checking for links between different seizures, for example, whether the same material type was uncovered on different occasions. In certain cases, an analysis of comparison samples may provide useful information. Source attribution is an iterative process, where investigation results are first compared against archive material or database entries (of known material). Based on the findings, a number of potential origins can be ruled out (exclusion principle).

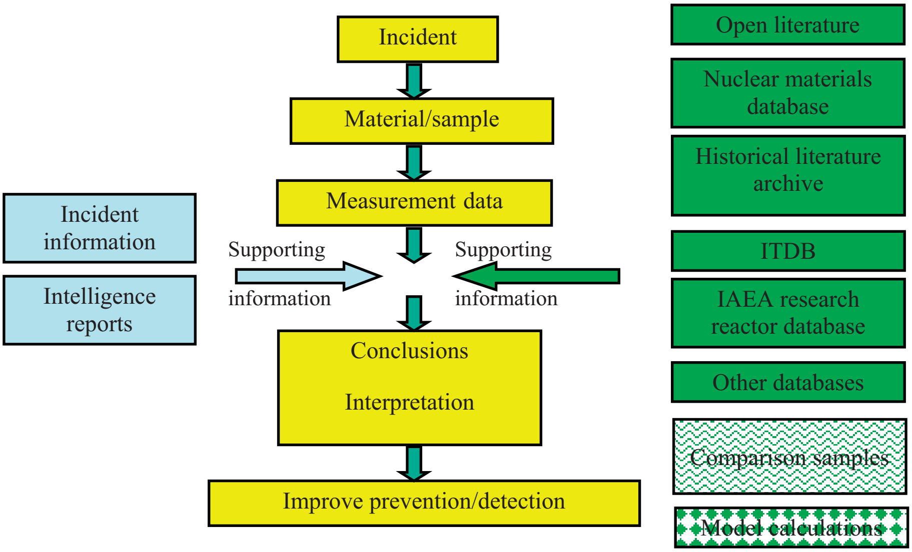

FIG. 2. Flow chart illustrating the importance of reference information for the interpretation of measurement data in nuclear forensic investigations.

The difference in certain parameters of the remaining candidate origins are used for guiding the next steps of the analysis.

4. APPLYING CLASSICAL FORENSICS TO CONTAMINATED EVIDENCE

Forensic science (often shortened to forensics) is the application of a broad spectrum of sciences for prosecution purposes. This may be in relation to a crime or to a civil action. Classical forensics basically aims at identifying individuals and at establishing relations between locations, events and individuals. It is based on the 'Locard principle', which states that whenever two objects meet, there is an exchange of material from one to the other [5].

Classical forensics relies on fingerprints, DNA ('genetic fingerprint'), fibre, hair, pollen, residues of explosives or gunshots. The sampling protocols and the treatment of the samples are well established. Nuclear forensics makes use of other parameters, such as the isotopic composition of the uranium or plutonium, chemical impurities, macroscopic appearance (e.g. pellet geometry), microscopic parameters (e.g. particle size distribution, grain size distribution, pore size distribution) or the isotopic composition of minor constituents (e.g. lead or oxygen). The methodology of nuclear forensics has recently been reviewed [6].

The application of classical forensics to contaminated items is an area that has been addressed only recently. Taking fingerprints or DNA samples from radioactively contaminated pieces of evidence requires an appropriate laboratory environment, that takes radiological aspects into account (protects the analyst from the radioactive material) but at the same time allows investigation of the evidence. A dedicated glovebox was constructed at ITU in collaboration with the German Federal Criminal Police (BKA). The glovebox contains a fuming chamber, for visualizing latent fingerprints using the cyanacrylate method (Fig. 3).

In parallel, experiments were conducted for determining the radiation stability of the 'genetic fingerprint'. Preliminary results suggest that the DNA can accept fairly high radiation doses before the fingerprint is corrupted. Other investigators came to similar conclusions in independent experiments [7]. The coordinated application of classical forensics and of nuclear forensics to items under investigation needs to be fully established and appropriate protocols need to be developed. These protocols should cover the management of contaminated crime scenes, sample taking in a contaminated environment, preservation of both nuclear and classical forensic evidence, chain of custody, handling of evidence in a nuclear laboratory and writing expert witness reports.

5. JOINT ANALYSIS — TESTING THE MECHANISMS FOR NUCLEAR FORENSICS SUPPORT

Many States do not possess their own nuclear forensics capabilities and a number of States have limited possibilities for nuclear forensic investigations. If nuclear material is seized and a forensic analysis beyond the technical capabil-

FIG. 3. Visualization of fingerprints using a dedicated set-up installed in a glovebox.

ities of the intercepting States is to be carried out, then the material has to be taken to a specialized nuclear forensics laboratory. The IAEA has issued a document [8] describing the relevance of nuclear forensics and the brokering role of the IAEA in providing nuclear forensics support. ITU has joint analysis agreements in place with a number of States, thus enabling nuclear forensic support. The execution of these joint analysis agreements has been tested in a number of cases, when material seized in a State was later shipped to ITU for detailed nuclear forensic investigation. Measurement experts from the requesting State participated in the analysis and in the data interpretation at ITU (Fig. 4). Based upon the joint findings, the national experts drafted the analysis report. In cases where the illicit trafficking incident went to court, the national experts would present the evidence in court. Joint analysis exercises were carried out with Lithuania, Poland, Ukraine, Czech Republic and Hungary; a joint analysis with Slovakia will come up shortly. ITU will continue conducting these exercises in order to be well prepared for the implementation of nuclear forensic support.

6. TRAINING — FROM AWARENESS BUILDING TO SPECIFIC KNOWLEDGE

Training is essential in order to provide all the actors involved in these incidents with the necessary knowledge and skills for properly, safely and securely handling a case. A comprehensive training plan was developed which

FIG. 4. A pellet seized in Lithuania was subjected to joint nuclear forensic analysis at ITU. Two measurement experts from Lithuania participated in the investigation. The pellet could be attributed to an RBMK-1500 reactor. The fuel was produced at Electrostal and the material was intended as fuel for the nuclear power plant in Ignalina, Lithuania.

comprises the development of a national response plan, the response procedures to be managed by the first responders, the support to be provided by measurement experts and the nuclear forensic investigation to be performed in a specialized laboratory. Finally, the awareness and alertness of the different actors, the appropriateness of the response plans and procedures are trained and tested in exercises.

Together with a number of partners, ITU and the IAEA have developed a comprehensive nuclear security related training scheme [9]. Training in nuclear forensics ranges from forensics awareness to specific technical training in the laboratory. In cooperation with the Forschungszentrum Karlsruhe (FZK), ITU offers nuclear forensics training courses for regulators, law enforcement and scientists. In the framework of the TACIS programme, scientists from cooperating countries are trained at ITU in nuclear analytical techniques (radiometric techniques, mass spectrometry, chemical separations, etc.) and in material science aspects (ceramography, electron microscopy, etc.).

7. INTERNATIONAL COOPERATION

Nuclear forensic science is closely related to the phenomenon of illicit trafficking and, thus, to nuclear security and nuclear safeguards. A border crossing threat is associated with it, hence calling for an internationally coordinated response. The ITWG was established some ten years ago, in order to advance the science of nuclear forensics for attributing nuclear material. This is achieved by exchange of information, by developing procedures and recommendations, and by exercises [10]. A number of bilateral programmes are also being carried out for fostering cooperation, for example, between the ITU and the Bochvar Institute in Moscow.

A number of bilateral or multilateral assistance programmes have been set up in order to improve detection capabilities, to harmonize response mechanisms and to arrange for nuclear forensic assistance. The IAEA also promotes the development of nuclear forensics and facilitates the provision of assistance to requesting States which do not have their own nuclear forensic capabilities. This is supported by a comprehensive training programme and by a coordinated research programme.

The exchange of information on nuclear materials as well as on analytical methodologies is often restricted, due to commercial sensitivities and for national security reasons. Overcoming these restrictions and establishing broad international cooperation appears highly recommendable in view of the threats of nuclear terrorism, which is unavoidably linked to illicit trafficking of nuclear material. Compiling all information available in different States and on all kinds of nuclear materials in a single, comprehensive database appears a remote idea, as sharing of data is limited by commercial sensitivities and by national security concerns. A possible way out would consist of allowing mutual queries to the existing databases, thus protecting the data and sharing only the results of the queries. To this end, a database of databases needs to be established, i.e. a compilation of information on databases with some generic information on the type of data they contain and an identification of the contact point and an indication of the conditions for a query. This decentralized approach may be easier to implement than a single centralized database [11]. Non-nuclear States also need to be involved in this effort.

8. CONCLUSIONS

Driven by the need to learn about the nature of material intercepted from nuclear smuggling and by the desire to determine the origin of the smuggled material, a new discipline in science evolved in the early 1990s from safeguards analytical techniques and from material science: nuclear forensics. Starting out as an ad hoc analysis, it rapidly developed into a methodical approach for identifying characteristic parameters in seized nuclear material, thus providing clues on the origin of the material. The analytical approach and the interpretation of measurement data were systematized and today a methodology is in place which enables credible results. International cooperation has positively advanced this development and nuclear forensic capabilities are available in several countries. Parameters such as isotopic composition, chemical impurities, age of the material, macroscopic parameters and microstructure provide clues on the origin and on the intended use of the material. A wide variety of analytical techniques, specifically adapted for measuring nuclear material, are used for investigating nuclear material intercepted from illicit incidents. Still, there is no silver bullet, no single parameter that would point at the source of the material. Source attribution requires the determination of a characteristic pattern of parameters and the availability of reference data for comparison purposes. Classical nuclear forensics techniques are being adapted for use with contaminated evidence.

The main challenges in the area of nuclear forensics are:

— The identification of additional parameters that are characteristic for the origin of a material, for the starting material used for its production or for the type of production process applied;
— The accessibility of databases for comparing data obtained on seized material to data from material of known origin and history.

Based upon the sound experience of real casework in 30 seizures and upon the associated development work, ITU has implemented effective and efficient nuclear forensics capabilities. These capabilities are strongly linked to international efforts in this area and are associated with all other response activities. A training and education programme complements the activity. Today, nuclear forensics has reached a high degree of maturity and is highly relevant in the areas of non-proliferation and nuclear security. Continued development activities and strengthened international cooperation will be of key importance to perfecting the discipline of nuclear forensics. Nuclear forensics is an integral part of the response to illicit incidents involving nuclear material. Most importantly, nuclear forensics provides sustainability in combating illicit trafficking, as it allows solving the problem at its roots by identifying the origin of the material.

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IAEA-CN-154/065

PROSECUTION FOR ILLEGAL POSSESSION, TRANSPORT, FRAUDULENT MISLABELLING AND EXPORT OF A RADIOACTIVE SOURCE
*The Nigerian experience**

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Company A had the authority to import radioactive sources and also to export them after use. The Nigerian Nuclear Regulatory Authority (NNRA) carried out an inspection and issued an export licence. Company A handed over the source illegally to unauthorized/unlicensed Company B to export the source for them. Company B was not only unauthorized but also had criminal tendencies, because they were aware that Mr. X repackaged the radioactive source to mislead the authorities and misdeclared it as a ‘mould design’. Company B paid Mr. X about US $300 as opposed to the US $3000 they had collected from Company A. Since there is no radiation monitor at the airport, the package could not be detected. However, Company A had disclosed to the manufacturer that the source would arrive with a particular airline. Company B, either to maximize their profit or to hide their intention, sent it with another airline. At London Heathrow Airport, hazardous goods are segregated from non-hazardous goods. The consignee went to receive the radioactive source at the hazardous section but it never arrived there. Later, a package was discovered in the non-hazardous section addressed to the manufacturer. At this point, the consignee alerted Heathrow Airport police who carefully removed the fibre board and discovered the export licence issued by the NNRA and then found the package to be radioactive. The United Kingdom authorities wrote to the NNRA who then reported it to the Nuclear Security Committee (NSC) which comprises the SSS, the police, the military and customs officials, the Ministry of Internal Affairs, the Ministry of Health and the Ministry of Justice. The NSC then ordered a full investigation to be carried out by the security agencies and the findings made were reported. The suspects were tried

* The full paper was not available for publication. The synopsis appears in its place.

on eight counts which included conspiracy; illegally exporting, repackaging and transferring the security responsibility of radioactive materials (depleted isotopes); disguising and misdeclaring them as 'mould return' from Nigeria to the United Kingdom; without valid authorization and in violation of the terms and conditions of the export licence issued by the NNRA. Company A pleaded guilty to Count 5 and tendered an unreserved apology to the Nigerian Government and the NNRA, and was convicted and fined. The managing director of Company B admitted in his statement to the police that he received, handled and transported the radioactive source from Port Harcourt to Lagos without authorization but denied exporting and mislabelling the isotopes, while Mr. X in his statement to the police admitted exporting and mislabelling the isotopes. At the trial, they retracted their confessional statements and pleaded not guilty, hence witnesses were called and exhibits tendered. Judgement was issued on 20 December 2006 after the suspects had been remanded in prison custody for 289 d as follows:

(a) Managing director, Company B convicted: 9 months imprisonment or fine of N 100 000;
(b) Lagos manager, Company B convicted: 9 months imprisonment or fine of N 100 000;
(c) Mr. X (mislabeller) convicted on four counts:
    (i) Twelve months imprisonment or fine of N 100 000;
    (ii) Twelve months imprisonment or fine of N 200 000;
    (iii) Twelve months imprisonment or fine of N 400 000;
    (iv) Twelve months imprisonment or fine of N 50 000.

IAEA-CN-154/062

THE FRENCH RESPONSE IN CASES OF ILLICIT NUCLEAR TRAFFICKING
Lessons learned from a real case

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Abstract

The paper describes the French response in the case of nuclear illicit trafficking attempts. Firstly, different categories of events are defined according to the nature of the materials involved and the reality of the threat induced. A short description is given of the Interministerial Central Detachment (in French, "Détachement Central Interministériel d'intervention technique" — DCI) response team. A logical description of the work from the crime scene to the final interpretation summarizes the methodological approach. Finally, this methodology is illustrated with a real case of illicit nuclear trafficking which occurred in France. The French 2001 seizure is described, just a few

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months after the last International Technical Working Group high enriched uranium exercise, which was treated with this methodology based on the acquired knowledge.

1. ILLICIT TRAFFICKING

To understand the terrorist's interest in nuclear materials, one should recall what is taught at business school: potential buyers make markets and the more difficult the products are to find, the better your business will be. This may induce different events, which we decided to separate into four categories.

The first one, called 'unachieved attempt', refers to undefined objects someone tries to sell for various prices up to unbelievably high prices. From time to time, we receive questions about these kinds of cases, looking for the real purpose, the reasons we would have to buy them and in this case, the way to handle them. We call them 'unachieved' because we always give up after enquiries. The trouble is that nobody notices this kind of offer in databases, which may help to reduce the frequency and number of this kind of offer.

The second one, not so different from the first, is called a 'hoax', according to the intent to make a convincing mock-up of commercial equipment supposed to contain the precious isotopes the buyers are looking for. In some cases, really good external copies are made that contain nuclear materials inside that emit a signal as close as possible to the supposed composition when detected.

These first two categories are a direct result of the potential market we previously talked about. Although they are not so dangerous, they waste the time (and sometimes money) of potential buyers, the most dangerous ones and us. The real question is whether we have to maintain this kind of offer.

The next category, which is much closer to loss of control, is luckily the most frequent in databases. It is not really connected with dangerous trafficking attempts. The material is usually discovered in scrap metals during efficient controls and is often transported from border control for disposal. This is a good opportunity to train response teams and to secure the materials involved.

The last category of event is the real trafficking attempts, whatever the quantities of seized material. These much more worrying events induce quite some work which can be divided into three main steps:

— Response teamwork with:
  - Threat credibility assessment;

  - Search of the nuclear or radiological materials with dedicated equipment: handheld detectors, detection vehicles and gamma airborne systems;
  - Pre-diagnostic (gamma spectroscopy, neutron measurements, imagery techniques such as X rays) on the field of the materials (with appropriate measures regarding safety) and materials first assessment;
  - Materials transport to an Atomic Energy Commission (CEA) secure storage, and shipping of samples to CEA laboratories for analysis.
- Technical laboratory analysis: This work is organized in a radiological forensic laboratory network. According to the first materials characterization and the sample's activity level, the seized materials are divided to be treated with the most efficient analysis methods (high resolution gamma spectrometry, TIMS, ICP-MS, physical structure, impurities, isotopic ratio, etc.);
- Final expertise: The main object of this activity is to define the real nature of the seizure, the age determination and the material's potential origin. Non-proliferation expertise and knowledge are associated to define the potential origin, source and materials route attribution.

2. RESPONSE TEAM

The Interministerial Central Detachment (DCI) was set up on 6 March 1995 to deal with a terrorist attack threat using chemical, biological, radiological or nuclear (CBRN) devices, or following the discovery of a device suspected to contain CBRN or similar materials for terrorist or criminal purposes. At the request of the General Director office of the National Police (Directeur Général de la Police Nationale (DGPN)), the DCI is placed on standby or deployed to work under the relevant territorial authority orders, which is the Prefect — the representative of the State at the local level. The DCI is able to deploy anywhere in France. The DCI is commanded by the head of the French Police Special Task Force (called RAID in French), an interministerial body with personnel from the:

- Ministry of Interior;
- CEA;
- Defence Ministry;
- Ministry of Health.

The DCI has three main tasks:

— To prevent or to limit the effects of an improvised CBRN device, with the use of all means available to search the device, to ensure its diagnosis and assessment, and finally to achieve its neutralization;
— To give technical assistance to the police, gendarmerie or customs services in the fight against nuclear illicit or other radioactive materials trafficking;
— To assist authorities with CBRN security at major public events. In recognition of the CBRN threat, the DCI has a role in the preventive measures which are systematically put in place during large scale events, such as football or rugby World Cups, G5 or G8 summits, a North Atlantic Treaty Organization (NATO) summit, etc.

In case of a nuclear or radiological materials illicit trafficking threat, CEA representatives (in the DCI framework) are on call 24 hours per day, 7 days per week and are dedicated to technically assessing the threat using dedicated tools (handbook, databases, etc.). The typical response time is one hour.

If the threat is confirmed, and depending on the case, a search operation could be setup to detect any abnormal radiation levels in a given area, to localize the radiation origin and to identify the involved radionuclides (confirm or not the presence of fissile material). This activity is conducted by the DCI search team. The team is led by a CEA engineer, and has three components (Fig. 1); depending on the case, one or several components could be used:

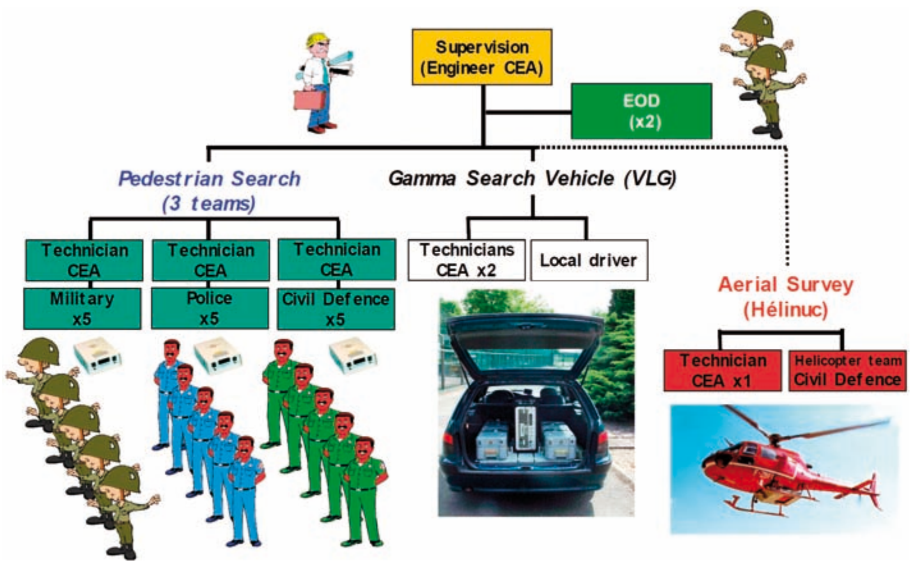

FIG. 1. Typical Interministerial Central Detachment operational search team.

— The pedestrian team, up to 15 people, is equipped with handheld gamma and neutron search detectors. Covert capabilities are available. The gamma detection tools used by the pedestrian team is the DG5 (manufactured by Novelec, under CEA licence), a plastic scintillation detector, with a fast response time and a high sensitivity;
— The vehicle search team is equipped with a 'véhicule de localisation gamma' (VLG). This tool is a moving detector (8 L of a sodium iodide crystals pack), which can be loaded in any vehicle, with the following characteristics: gamma detection in spectroscopic windows, radionuclide identification, GPS localization, dedicated algorithm for signal processing (CEA patent);
— The aerial team is also dedicated for a wide area search. Twenty years ago, the CEA developed an airborne gamma mapping system known as Hélinuc. It can process an area for radiological analysis from a few square kilometres to several hundred square kilometres in a few hours, identifying the radionuclides with a sensitivity ranging from background radiation level to that of a serious emergency situation. Hélinuc can also be used for rapid detection and location of orphan radioactive sources. The main detector is a 16 L sodium iodide crystals pack inside a dedicated container fitted under the helicopter. There are also two 70% germanium detectors, one on each side of the container. The French system Hélinuc was used in 2000 to assist Georgia (IAEA Project GEO9006-9002) to look for orphan sources on its territory.

In addition, we can deploy numerous portable portal systems.

When the material is found by the search team, the CEA diagnostic team is in charge of determining, in the field, the nature and geometry of the material and surrounding materials (shielding, etc.). The following techniques are used:

— Gamma spectroscopy;
— Neutron measurements;
— Imagery techniques such as X rays, gammagraphy, etc.

These measurements are performed with appropriate actions regarding safety. A first assessment of the material is given, if needed, by the CEA headquarter crisis centre help (using secure communication means between the field and CEA's headquarters).

The support team is in charge of the materials transport to a CEA secure storage site. From the storage place, where complementary non-destructive analysis could be performed, samples are sent to CEA laboratories for analysis.

3. TECHNICAL LABORATORY ANALYSIS

The first step of this work, directly on the crime scene, does not induce major difficulties as long as it is driven by police forces with experts in nuclear field assistance. The ‘non-nuclear’ component characterization can be divided into two classical phases. The first one named ‘classical forensics’ is specifically police laboratory work. The second one might be shared by many different laboratories with a specific add on given by nuclear laboratories upon the classical materials used in this industry.

The most critical phase is the nuclear material analysis itself. A clearly methodological approach has to be led with organized cooperation between nuclear and traditional forensics experts. In this domain of activity, the International Technical Working Group (ITWG) provides really good support, combining nuclear laboratory expertise, investigation protocol studies and best practice technical recommendations.

Most of the time, this work is divided into three steps just like the ITWG training exercises. The first one during the response team operations is used to qualify the event. The next one tries to define the real quality of the nuclear materials and the last and longest one is reserved to provide a complete analysis and the expertise of the involved materials.

4. FINAL EXPERTISE

The last step of expertise is much closer to the non-proliferation work. Assumptions regarding the real nature and material origin are built on the previous analysis in close correlation with the non-proliferation knowledge. This expertise extends as much as is possible to the involved material’s potential use.

5. CASE OF THE 2001 SEIZURE IN PARIS

In July 2001, the national security service was informed that a man wanted to sell high enriched uranium (HEU) samples in Paris. The ‘seller’ says that he has the capacity to provide 30 kg within a few days. The man is well known as a crook by the police, however, an operation is decided by the service in charge of this type of crime. The DCI provided technical support to the police teams.

5.1. Response phase

It was first planned to search in the seller's apartment and garage with pedestrian teams: no positive detection was observed. From intelligence, it was known that the individual had a meeting at La Place de la Nation, in the east of Paris. Under covert search, the DCI team detected a radiological anomaly in a vehicle. It was decided necessary to confirm the alarm and the police decided to arrest the perpetrator. A police operation took place: two people were arrested, two vehicles were seized and there was a fast search in the cars. A lead container with a radioactive sample was found (Fig. 2).

A pre-diagnostic (Fig. 3(a)) was done by CEA technical experts of the DCI at the police station. One concern was the risk of contamination. Using a small NaI detector, the sample was very quickly identified as ^{235}U. Gamma spectrometry (Fig. 3(b)) was then performed and gave the following information:

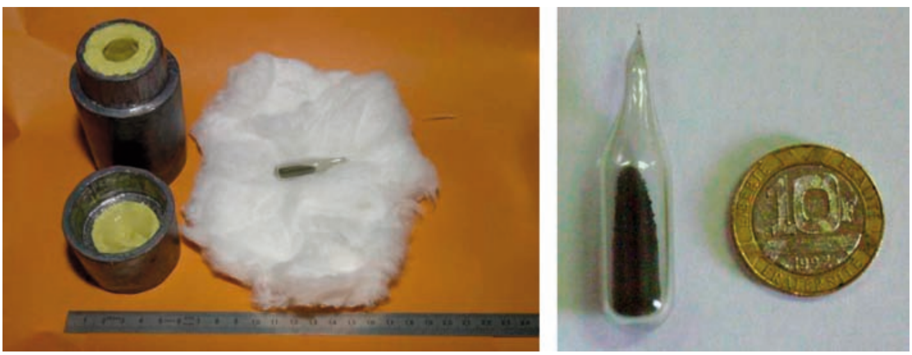

FIG. 2. Picture of the sample seized in Paris in 2001.

(a) (b)

FIG. 3. Pre-diagnostics at a police station in Paris.

— Identification confirmation;
— Isotopic ratio: 70% ^{235}U;
— Presence of ^{232}U as an impurity, which probably indicates reprocessing uranium.

In this joint team (police and CEA technical expert), classical forensics (Fig. 4) was also used in the field by police for the criminal investigation. Special attention was paid firstly to combine police expertise and radioactivity and, secondly, not to destroy any other evidence (such as fingerprints and DNA) during radioactive item analysis.

The operational response team made all the arrangements for the radioactive item's transport after risk of contamination elimination and taking into account the risk of irradiation. The seized material was sent to an appropriate location for temporary storage at the CEA: the item was secured and was only accessible for authorized personnel. The material was sampled, taking care to preserve classical forensics. The samples were sent to a CEA laboratory for deeper analysis (nuclear forensics).

5.2. Technical laboratory analysis

A lead cylindrical container with wax inside was used to confine a glass ampoule that contained the sample powder (Fig. 2):

— Lead container with 5.7% antimony;
— Paraffin wax charged with 23% barium chromate;

FIG. 4. Classical forensics.

— Polyurethane foam;
— Borosilicate glass ampoule O;
— 468 mg of material.

The isotopic analysis gave the results shown in Table 1.
The main impurities were:

— Silicium 8600 ppm;
— Borum 430 ppm;
— Magnesium 380 ppm;
— Calcium 800 ppm;
— Aluminium 300 ppm;
— Iron 100 ppm;
— Titanium 35 ppm;
— Zinc 50 ppm.

Sicilia and boron may come from the glass tube (Pyrex with 11% boron).
The materials' age was calculated using ^{230}Th. It is reasonable to estimate a storage phase between six and seven years before seizure.

5.3. Final expertise

The analysis results gave a good correlation with the result of high enriched light water reactor fuel reprocessing. 90% nuclear fuel with a burnup of 350 000 000 MW·d/t.
The cycle might have been:

— Enrichment between 90 and 93.2% of material containing U6;
— Conversion to U metal;
— Fuel elements realization type UA1 or UZr or UO_2;
— Use in research reactor with a 350 000 000 MW·d/t burning rate;
— Good batch reprocessing;
— Conversion to UO_8 powder.

This sample really looks like the one in the Bulgarian case (May 1999).

TABLE 1. ISOTOPIC ANALYSIS

U2	U3	U4	U5	U6	U8	Pu/U
9.36×10^{-7}%	<5.82×10^{-5}%	1.17 ± 0.02	72.57 ± 0.86	12.15 ± 0.14	14.11 ± 0.08	2.2×10^{-9}

IAEA-CN-154/044

RESPONSE TO A DETECTION INCIDENT
The IAEA MEST concept

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Abstract

Experience in Member States has shown that frequent radiation monitoring at borders or within a country results in a significant number of radiation alarms, where most of them are of an innocent nature, i.e. caused by naturally occurring radioactive material, by pharmaceutical radionuclides in persons who have had medical treatment or by legal radioactive shipments. The rapid resolution of innocent alarms, with an acceptably low level of vulnerability to overlooking a threat isotope, is one of the most important tasks in radiation monitoring. In this process, the impact on the free flow of goods and passengers must be minimized. This problem area is also the driving force for R&D in the field of radiological security. Since frontline officers (FLOs), i.e. customs, police, border guards and security, are not experts in radiation detection, practice in Member States has shown that they can be successful only if reliable expert support is available. If not, the FLOs may become insecure and may not be able to carry out radiation monitoring effectively. How this support is set up by different Member States differs. There are several areas where expert support is needed: initial detection phase, emergency response if required, nuclear forensics and attribution, not to forget threat assessment, equipment purchasing, installation, maintenance and training. In the paper, the mobile expert support team (MEST) concept is discussed, as introduced in Member States, supported by the IAEA to provide support in the initial detection phase and often also in other areas discussed. It consists of various components, such as equipment and techniques used by analytical experts and radiological assessors, procedures and a training programme, emphasizing the operative interaction between FLOs and the MEST.

1. INTRODUCTION

Starting in the mid-1990s in many countries (i.e. Russian Federation, Poland, Finland, France and some newly independent States), radiation monitoring at border crossing points was introduced to detect smuggled nuclear and other radioactive materials (see the corresponding papers of this conference). This was also widely done in the USA after 11 September 2001, with their intensive efforts to improve homeland security, including large scale radiation monitoring at land and sea borders and within the country, for example, during major public events and in cities. In Europe, the European Union provided support for the installation of radiation detectors at borders under the TACIS and PHARE programmes, and through the IAEA in new European Union Member States, the Russian Federation, Africa, and in the Balkan and newly independent States.

At that time, the IAEA had also started to support those Member States with weaknesses in radiation detection at borders all over the world with advice, equipment and training.[1]

The experience gained by Member States and the IAEA has shown that radiation detection by frontline officers (FLOs), i.e. customs, border guards, intelligence and security at borders and within a country can only be successful if, among other things, a reliable and effective scientific and technical expert support scheme is in place to assist, if required, in the alarm response process (i.e. radiological assessment, radionuclide identification, securing of evidence, transport and characterization).

In this paper, we briefly review alarm response procedures implemented by Member States to address encountered problems. This is followed by a description of the concept, developed at the IAEA, to establish expert support for FLOs. Since its main component is an operative expert group, which can also move to the field, it has been named the ‘mobile expert support team’ (MEST) concept.

2. NEED FOR EXPERT SUPPORT

According to experience in the USA, the Netherlands, the Russian Federation and the United Kingdom, about 1% of trucks passing a radiation portal monitor at a border crossing point trigger an alarm, requiring a secondary inspection with a radionuclide identification device (RID) to categorize the radionuclide. For a busy border crossing point, where 5000 trucks pass each day, this would be about 50 secondary inspections per day. In about 98% of these cases, the alarm can quickly be resolved with the RID. Up to 2% of the alarms, however, cannot be resolved by the FLOs with the present generation of RIDs (see Section 5) and detection expert support is needed. In addition, there could

[1] For details, see: http://www-ns.iaea.org/security/default.htm

be a certain (lower) number of radiation alarms that have a criminal intent, requiring in situ investigations. Thus, there would be about one case per day requiring assistance, illustrating the magnitude of the problem. If such support is not available, FLOs may become insecure, may reduce the sensitivity of the detection equipment to avoid frequent alarms at low radiation levels, detection follow-up may not be performed properly, incorrect conclusions may be drawn, relevant cases may be missed or no adequate response to a radiological danger may take place.

We observe differences in how detection expert support is set up by different Member States. In the next section, examples of schemes used in various countries are given, followed by a description of the MEST concept suggested by the IAEA in order to build an expert support capacity in Member States, particularly those in the initial phase of establishing detection and detection response capabilities with the help of the IAEA.

3. EXAMPLES FROM MEMBER STATES

We distinguish here between radiation detection followed by response to alarms, and emergency response (although sometimes performed by the same group, which must then have dual expertise). Emergency response measures and procedures for natural and technical disasters have existed for decades in nearly all countries. Depending on whether nuclear facilities (i.e. nuclear reactors, isotope production and irradiation facilities, industrial and medical sources) are used in the country or in the region, the radiological component of emergency response plans may be more or less developed.

Administrative and technical infrastructures, training and national response plans for radiation detection at borders and the required detection expert support are different from emergency response. Such measures are often new for countries introducing radiation monitoring but need to be established to be successful. Therefore, detection expert support for FLOs is the subject of this paper.

The detection support schemes for FLOs (reachback) used in Member States can be divided into two groups, referred to here as A and B.

In Group A, FLOs operate the detection equipment to:

— Detect the presence of radiation;
— Verify a radiation alarm;
— Localize the source;
— Make a first estimate of the gamma ray dose rate;
— Categorize the source with an RID;

— If the FLOs encounter any problem in making a decision (see decision points ‘D’ in Fig. 1), or if a criminal act is involved or suspected, or there is the danger of a radiological emergency, an expert support group is contacted for assistance.

This scheme requires training of the FLOs in the use of RIDs and the interpretation of the results, which is more demanding compared to the use of detection devices. In many cases, however, decisions can often be made on the spot within minutes. If problems occur, expert support is available — remotely in large countries, as a rule.

In Group B, the FLOs operate the detection equipment to:

— Detect the presence of radiation;
— Verify a radiation alarm;
— Localize the source;
— Make a first estimate of the gamma ray dose rate;
— STOP on a verified alarm and contact experts;
— Experts assist remotely or come to the field.

This scheme requires the FLOs to have training in radiation detection, while the more complicated task of categorization with the RID and the radiological assessment is left to experts. This is, however, at the expense of a larger time delay between detection, categorization and decision making.

Below, some examples are given on how detection and reponse is organized in some Member States.

3.1. United States of America

In the USA, the radiological component of emergency response has been well developed for decades. Before 11 September 2001, while few customs officials had personal radiation detectors (PRDs) and RIDs, radiation detection was mainly addressed at the gates of nuclear facilities to prevent the unauthorized or inadvertent movement of nuclear and other radioactive isotopes, or at scrap yards to detect lost and uncontrolled sources that had ended up in the scrap.

After 11 September 2001, a large number of radiation portal monitors (RPMs) were installed at land and sea borders (over 1000 by the end of 2007), complemented by more than 10 000 PRDs. Radiation monitoring is also performed at major public events, such as the Super Bowl, political conventions, the Olympic Games or in big cities, when there is a high threat level. The large number of cases requiring support necessitated the development and introduction of various technical and administrative measures and procedures to provide detection support to the FLOs, who in the USA do not only operate the RPMs but also do the categorization of the radioactive sources with an RID in case of a radiation alarm. If problems arise, technical support (primary reachback) is organized and provided by the Laboratory and Scientific Services (LSS) [1]. LSS coordinates technical and scientific support to all customs and border protection (CBP) trade and border protection activities. Working in laboratories in eight major cities, LSS scientists provide scientific advice to the rest of CBP. If, in difficult cases, more specific gamma analytical expertise is required to identify the radionuclide(s) uniquely, or if nuclear material is involved, a secondary reachback capability (triage) is activated [2]. This support is provided by highly specialized gamma spectrometric analysts at three national laboratories of the USA (Sandia, Los Alamos and Lawrence Livermore). Secondary and primary reachback are mostly provided remotely with short response times, using gamma ray spectra measured with RIDs on the spot and other relevant information, transmitted over the Internet. Experience in the USA has shown that the quick resolution of innocent alarms, with a high level of assurance that no threat isotope is overlooked, is decisive for the success of radiation monitoring at borders or in a country. It is also the driving factor for R&D in homeland security as supported in a programmatic manner by the Domestic Nuclear Detection Office (DNDO) [3].

In case of a radiological emergency (either real or potentially developing in conjunction with a detection incident), the radiological assessment program (RAP) team [4] provides operative on-site support. If nuclear material or even a nuclear weapon is suspected to be involved, a special unit, the nuclear emergency support team (NEST), is called in [5].

3.2. Russian Federation

Large scale radiation monitoring at borders has been implemented, assisted by the US Department of Energy (USDOE) second line of defense (SLD) programme, since the middle of the 1990s. Presently, several hundred RPMs are deployed and about 200 more are planned to be installed in the near future. Radiation detection and categorization is done by FLOs (customs), often with specialized expert knowledge in this field. This applies in particular to the verification of legal radioactive shipments, which must pass one of the special customs houses that have technical facilities to identify the radionuclide, estimate the activity (or mass) of a source or nuclear material in a closed shipping container, without opening it [6]. In 2007 alone, Russian Federation customs' radiation monitors went off 65 000 times, and it was revealed that in 850 cases, radioactive goods were being transported illegally across the border.

Centralized expert support is provided through a ‘line of connection’ scheme with a customs response and control centre for fissile and radioactive materials in Moscow (established by a joint Russian Federation–USA project under the US SLD programme). In trafficking cases involving criminal activities, samples of the seized nuclear or radioactive materials are analysed by certified analytical laboratories to provide support for the court case.

3.3. France

Search teams and FLOs use handheld gross gamma ray search detectors for radiation checks. They do not operate RIDs to categorize a source. Nearby laboratories specialized in analytical detection support exist in the nine districts of the country. Experts provide support with radionuclide identification by travelling to the field.

3.4. Finland

In Finland, FLOs (customs) operate the RPMs at borders. In the case of a verified radiation alarm, experts from the Radiation and Nuclear Safety Authority (STUK) provide specialized analytical detection support.

The situation described in these examples occurs in all countries that have active radiation detection programmes. The kind and frequency of required expert support, however, depends on various factors such as:

— Categorization of a source performed by the FLOs with RIDs, or by detection experts called in, which causes a significant delay;
— Quality of the RIDs used for the categorization and their technical conditions (e.g. well calibrated and maintained or not);
— Level of training and experience of the FLOs;
— Throughput of persons and goods at a border crossing point and the maximum delay that can be tolerated before decisions are made.

4. IAEA MEST CONCEPT

The generic scheme of detection and response to a radiation alarm as adopted by the IAEA is presented in Fig. 1 [7, 8]. According to this, it is suggested that well trained and equipped FLOs operate the radiation detection equipment at border crossing points and also perform the secondary inspection by categorizing the seized source, using an RID with a search function and dose rate indication.

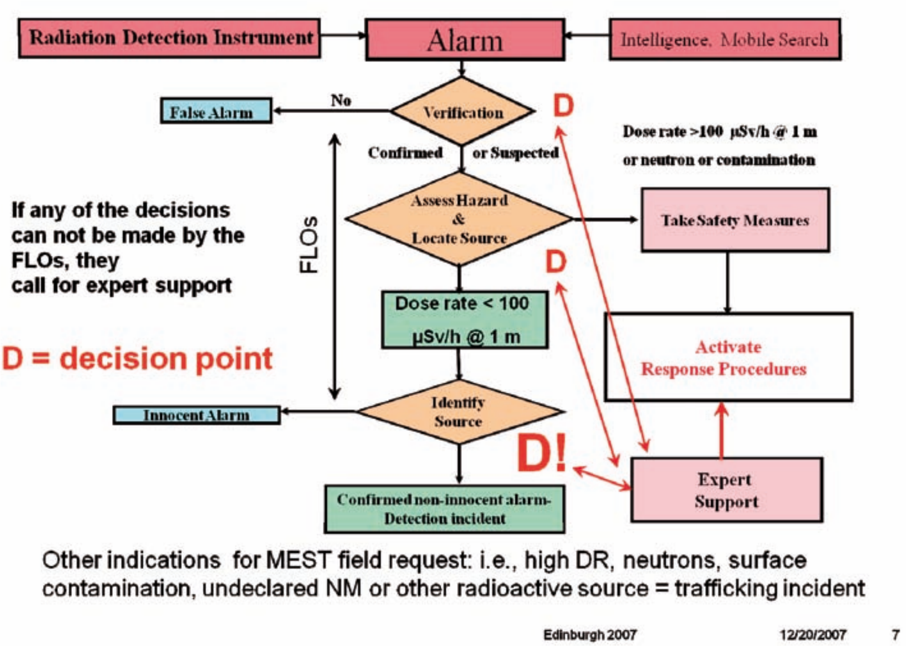

FIG. 1. Response to a radiation alarm and decision points that may require expert support.

Expert support may be needed in all phases of the detection and response process, that is, to:

— Exclude a false alarm caused by equipment malfunction;
— Categorize the source if the RID does not give an unambiguous answer (see examples below);
— Assist with the initial radiological assessment;
— Activate the national detection incident response plan in the case of a suspected criminal activity;
— Decide whether a radiological emergency is likely to require invoking the radiological emergency response plan;
— Assist the police and nuclear forensics experts in the collection and preservation of evidence.

As mentioned above, the IAEA recommends the following scheme for Member States where radiation monitoring is being established:

— Radiation monitoring and categorization of a radiation alarm with RIDs is done by FLOs (either customs, border guards or law enforcement officers, depending on the legal basis in the country);
— Detection support is provided by a specialized group, operating either remotely or by moving with equipment to the field (MEST).

The expert team members must have experience, training and equipment to cover, among other things, the following tasks:

— Analytical radiation detection support and documentation;
— Assessment of the radiological hazard;
— Awareness of classic and nuclear forensic crime scene work, cooperating with the police;
— Safe transport of the seized source (issuing a provisional shipping certificate based on field measurements) to a storage facility or laboratory;
— Analytical investigations, to characterize a seized sample in an NDA laboratory, to provide evidence in a court case;
— Liaison with regional or international organizations (i.e. IAEA, European Union), if detection incident or nuclear forensic support are required.

In smaller countries, the MEST may be the only group with experience in border monitoring equipment and its use. Therefore, they may also be involved in project preparation and equipment purchase, deployment, maintenance, performance monitoring, recalibration and training of FLOs.

The interaction between the MEST and FLOs is suggested to take place in the following stages:

Stage 1

Communication over the telephone, fax, Internet, etc.

FLOs are to describe the problem and any relevant circumstances, including:

— Indications of the RPM, PRD or RID, including signal magnitudes (gamma or neutron count rates, dose rates) and distributions (flat profile of and extended source or distribution with a flat peak);
— Route, shipper, receiver, shipping manifest;
— Any other observations.

Stage 2

Transfer of gamma ray spectra from the RID to a personal computer and sending them to the MEST.

The MEST has analytical experience and specialized software to evaluate the gamma ray spectra and other relevant information, correcting gain shifts and other disturbances, which may have caused an instrument failure to identify a radionuclide. To support spectrum transfer, the RIDs used must come with intuitive transfer software that can be used by FLOs.

Stage 3

The MEST, with experts and equipment in a vehicle, travels to the site. The first task for the radiological assessor of the team is to evaluate the radiation hazard. If there is one for the FLOs or the public, the corresponding emergency response plan must be invoked. Otherwise the radiation source is further investigated in the field, using specialized equipment (battery powered, light, portable, easy to use under field conditions), including:

- Well calibrated gamma ray and neutron dosimeters and surface contamination counters. These instruments are needed for the radiological assessor of the MEST;
- A hand portable high resolution gamma spectrometer to be used by the analyst of the team and consisting of the following components:
  - Compact high purity germanium (HPGe) detector (liquid nitrogen or electrically cooled);
  - Battery powered miniature MCA;
  - Notebook computer, desirably with daylight readable display and long battery life for data collection and evaluation under field conditions;
  - Easy to use software for data collection and evaluation (advanced isotope identification software with extended libraries for NaI and HPGe detectors, catalogues of gamma spectra and isotope databases, software for activity assessment of sources in shielding containers, estimation of the enrichment of seized U samples and isotopic composition of Pu);
- Well calibrated and maintained RIDs for use in expert mode;
- Neutron search detector to quickly localize a neutron source;
- Human portable, spectrometric gamma and neutron search equipment with GPS and mapping software if an extensive source search operation is required;
- Protective means and kits for taking swipe samples;

— Transport containers;
— Communication and documentation equipment (i.e. digital cameras, notebook computers, GPS).

The goal of this in situ investigation is also to obtain as rapidly as possible as much information as possible on the source, that is, whether it has caused an innocent radiation alarm, not masking a threat isotope, or whether nuclear or other radioactive materials are involved that are being moved without authorization. In the case of an innocent alarm, the person or the vehicle should be released quickly. However, decisions must also be made, whether other relevant authorities, such as the Ministry of Health or Environmental Affairs, should be involved.

In the case of a verified non-innocent alarm, the initial investigation also has the following goals:

— To perform an assessment of the radiological security assisting the FLOs with cordoning off the area and notifying the authorities in case a radiological emergency is present or likely. In some countries, the MEST members may also act as emergency responders but this dual function requires training in both fields and corresponding sets of equipment;
— To cooperate with the police to secure and document forensic evidence for the later court case;
— To make an initial characterization of a seized sample to:
  - Determine the severity of the case (i.e. inadvertent movement or attempted smuggling of weapons grade nuclear material, requiring immediate high level response);
  - Obtain enough information (e.g. through NDA measurements) to allow the issue of a provisional shipping document, which is needed to get the sample transported away from the border crossing point, without delay.

In the case of a suspected booby trap or a radiological dispersal device (RDD), the MEST should cooperate with the bomb squad to assist them with the identification of the radionuclide(s) and the estimation of its (their) activity. This information is needed for decision making (i.e. delaboration on the spot, contained explosion, transport, evacuation, etc.). For this, remotely operated, portable spectrometric equipment is needed, coupled to the robot used by the bomb squad.

The equipment, knowledge and expertise of the MEST members must be adequate to perform the described tasks. There are various suitable devices and software on the market that have been evaluated from the point of view of performance, usability and cost effectiveness. They are purchased by the IAEA for training courses and in support of established MEST programmes in relevant countries.

It is noted that the MEST concept has also been adapted to support the radiological security of major public events [9–11]. In such cases, the officers at the security gates, for example, of a stadium, may use radiation detection equipment — PRDs. As outlined above, they may subsequently also use an RID to categorize the radiation alarm. Alternatively, a nearby member of the MEST may do this job. This reduces the training requirements for FLOs, but requires a large number of experts. Additional centralized expert support, with portable high resolution gamma spectrometers, should be available for cases that cannot be handled with a NaI detector based RID.

5. DESCRIPTION OF DIFFICULT CASES ENCOUNTERED REQUIRING MEST SUPPORT

Some typical problems that, according to our experience and that of other groups, can occur and require expert support are presented below.

5.1. Identification failure due to gain drift of the RID

RIDs used under field conditions are exposed to high or low temperatures and to wide dose rate ranges. If they do not have effective energy stabilization, peak drifts occur. The performance of the isotope identification software is very sensitive to gain drifts and no, or wrong, results may be produced. Experts may still be able to extract results by correcting gain drifts and by processing the distorted gamma ray spectra.

5.2. Decay of the main isotope and wrong interpretation of impurities

A ^{252}Cf neutron source had to be checked with an RID. The device correctly showed a neutron alarm. However, when radionuclide identification was performed, ^{239}Pu and not ^{252}Cf was indicated. A detailed investigation with an HPGe detector showed that the main isotope ^{252}Cf had decayed (half-life only 2.46 a) and the gamma ray spectrum was dominated by ^{249}Cf. This isotope has a much longer half-life (350 a) and a gamma ray line of 388 keV that was improperly attributed to ^{239}Pu. The correct response of the RID should have been ‘not in library’.

5.3. False neutron alarm

The neutron detectors of some RIDs are too sensitive to gamma ray radiation. If the gamma ray dose rate exceeds several 10^{th} μSv/h, false neutron alarms are indicated although no neutrons are present. Since neutron alarms can indicate the presence of threat isotopes, this is very undesirable.

5.4. ^{90}Sr indication and failure to detect strongly shielded sources

The present generation of RIDs cannot recognize the structureless bremsstrahlung spectrum of a ^{90}Sr source. In such cases, a high gamma ray dose is indicated, but no identification results. The same can happen if strong sources in heavy shielding containers are encountered. The main gamma ray peaks are attenuated and the remaining spectrum of scattered gamma rays cannot be identified.

5.5. Misinterpretation of yellow cake as high enriched uranium (HEU)

Some RIDs attempt to estimate whether a uranium sample is depleted, natural, low or high enriched, by comparing the intensity of the ^{235}U 185 keV peak with that of the 766 and 1001 keV peaks of the ^{238}U daughter ^{234m}Pa (produced through the ^{238}U –> ^{234}Th –> ^{234m}Pa chain). If, however, after the production of yellow cake, the equilibrium with this ^{238}U daughter is not yet reached (time since separation < about 3 months), the peaks of the ^{238}U daughters are weak (relative to the ^{235}U peak) and the material looks like enriched uranium and may be indicated by RIDs as such.

5.6. ^{109}Cd identified as uranium or ^{133}Xe

^{109}Cd (often used as a calibration source) is not required to be in the library of an RID. If it is in the library, however, its gamma ray lines overlap with U X rays and a strong ^{133}Xe line. A false positive indication of U and ^{133}Xe may occur. However, ‘not in library’ should be indicated.

5.7. Indication of ^{241}Am as ^{57}Co

If an RID with an inefficient pile-up rejecter is exposed to an ^{241}Am source with ten or more μSv/h, pulse pile-up may cause the appearance of a significant gamma ray peak at 120 keV. This is misinterpreted as ^{57}Co, which only has one gamma peak at 122 keV that can be used for the identification with NaI detector based RIDs.

5.8. Misinterpretation of shielded Pu as ^{137}Cs

If an old Pu sample (high ^{241}Am content) is placed in lead shielding about 5 mm or more thick, the typical low energy Pu peaks are absorbed. Since the sample contains a high yield of ^{241}Am, its otherwise weak 662 keV peak is enhanced and an RID may misinterpret it as ^{137}Cs.

5.9. False positive indication of nuclear material

The backscattering peak of a high energy gamma ray peak has an energy that is difficult to distinguish from the 186 keV peak of ^{235}U with a NaI detector. Therefore, a false positive indication of ^{235}U may occur. Other false positive indications of ^{237}Np (for unshielded ^{192}I), ^{239}Pu (for ^{177m}Lu) and uranium are reported in Ref. [2].

To stimulate the improvement of RID performance by equipment vendors, we suggest introducing a weighing scheme (failure rating of the identification result), based on the severity of the consequences of a misidentification. If, for example, nuclear material (HEU or Pu) is incorrectly indicated as a medical isotope, the person may be released, which has severe consequences. Therefore, a device with the potential for such misinterpretation should be rejected. If, on the other hand, one type of nuclear material is indicated by mistake as another one or as an industrial isotope, the consequences are less critical, since MEST support is needed anyway and the wrong interpretation will be corrected by using an HPGe based gamma spectrometer.

6. CONTAMINATED MATERIALS

Other cases where expert support is needed are radiation alarms caused by foodstuffs, building materials, tiles, ceramics or scrap. There are national concentration limits for contaminations in such cases. They can only be checked by experts analysing a sample in an NDA laboratory to determine the isotope and its concentration.

7. ADVANCED EQUIPMENT TRAINING FLO–MEST

Currently delivered as a regional training course, the IAEA advanced detection equipment (ADE) course provides a learning opportunity for both FLOs and MESTs within the MEST concept (Fig. 2). The focus of the training course is to enhance the relationship between FLOs and MESTs through the use of practical exercises that would require the two disciplines to work together to achieve a common goal to make a decision on how to resolve a radiation alarm.

Very often, training courses are held where the participants are from a particular background, such as MESTs or FLOs, representing technical or non-technical proficiency in the radiation detection field, respectively. While these separate training courses build expertise, competency and confidence in the awareness, use and deployment of radiation detection equipment and interdiction capabilities, the ADE course unites the technical with the non-technical expertise, providing a solid means and understanding of expert support.

Although the number of participants (ideally 18 participants comprising 12 FLOs and 6 MEST members) is limited due to the type of information shared, the complexity of the simulation exercises and the number of instruments available, its format is quite engaging. The course format is based upon the three stages previously mentioned in this paper utilizing theoretical lectures and exercises of a practical and simulation nature (one simulation exercise for each stage). All activities build upon each other as the participant progresses through this one week training course, concluding with an overall understanding of the MEST concept and the necessary FLO and MEST inter-relation that should be established and developed to resolve detection incidents.

FIG. 2. Advanced detection equipment training course — transfer of gamma spectra from an RID to a notebook computer and re-evaluation by MEST analysts to identify radionuclides not ‘seen’ by the RID.

8. COLLECTIVE EXPERIENCE

Experience in various Member States has shown that radiation monitoring at borders and within countries is not sustainable without being complemented by an effective expert support concept. The IAEA has developed and implemented a concept that is based on a MEST — an expert group that provides support to FLOs — either remotely or in the field. The concept includes equipment and techniques, procedures and training, and has successfully been implemented in a number of Member States that are supported by the IAEA.

9. THE WAY FORWARD

Gamma spectrometry based radionuclide identification is one of the key elements in the provision of decision support on how to proceed after a radiation alarm. Therefore, further improvement of this technique in RIDs, automated spectrometric portals and human portable gamma spectrometers is envisaged. This applies to the speed, reliability and sensitivity of the categorization process — in particular, so that the many innocent alarms are taken care of quickly. “Discriminating against what you don’t want to alarm on is the first step in alarming on what you do.” [2]

Compact, portable, electrically cooled HPGe detectors, new large-volume, spectrometric, pixelated CZT detection systems with compton imaging having a volume of several 10 ccm and a resolution of <2% for ^{137}Cs, and large volume LaBr-3 scintillation detectors with a resolution of about 2–3% are expected to be implemented. Small LaBr-3 detectors coupled to solid state photodetectors or CZT detectors become the basis for spectral personal radiation detectors (SPRDs) and intelligent personal radiation locators (IPRLs), which can integrate digital images, sound and GPS coordinates with the collected gamma spectra, allowing — if networked — to determine the location of the source in a crowd. Improved, more effective methods of radionuclide identification, making use not only of gamma ray peaks, but of all information in the spectrum are being implemented. All new technical measures need to be accompanied by an effective training programme, not only for FLOs but also for MESTs, based on validated detection and detection response procedures.

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RECENT ACTIVITIES OF THE NUCLEAR SMUGGLING INTERNATIONAL TECHNICAL WORKING GROUP TO THWART ILLICIT TRAFFICKING

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Abstract

The Nuclear Smuggling International Technical Working Group (ITWG) is an informal association of nuclear forensic practitioners working in partnership with law enforcement, first responder and nuclear regulatory professionals that cooperate to deter the illicit trafficking of nuclear materials. The objective of the ITWG is to advance the science of nuclear forensics and to provide a common approach and effective technical solutions to governments who request assistance. The ITWG was created in 1996 and since that time over 30 nations and organizations have participated in

12 annual meetings and two analytical round robin trials involving plutonium and high enriched uranium. A third analytical round robin as well as several table-top exercises are planned for later in 2007 and 2008. International interest in the ITWG has grown over the past five years as measured by the number of participants at its annual meetings. This growth has spawned the ITWG Nuclear Forensics Laboratories as a companion technical affiliate focusing exclusively on the scientific aspects of nuclear forensics and nuclear smuggling incident response.

1. CREATION OF THE NUCLEAR SMUGGLING INTERNATIONAL TECHNICAL WORKING GROUP (ITWG)

The impetus for the Nuclear Smuggling International Technical Working Group (ITWG) came over a decade ago from the recognition that international cooperation in nuclear forensic analysis is an effective means to combat nuclear smuggling. At the time, there was acknowledgement that informal communication and cooperation among experts was the preferred means to meet this objective. This approach was further endorsed at the G7+1 summit held in Ottawa, Canada, in 1995 and confirmed in the G7+1 nuclear safety and security summit held in April 1996 in Moscow, Russian Federation. The genesis of the ITWG can be traced to the International Conference on Nuclear Smuggling Forensic Analysis held at Lawrence Livermore National Laboratory, USA, from 7 to 9 November 1995, where a total of 14 countries or international organizations agreed on the desirability of establishing an ongoing forum for international cooperation in nuclear forensics.

For the purposes of this paper, the term nuclear implies both nuclear and other radioactive materials.

The terms of reference state that the ITWG will evaluate present capabilities for combating nuclear smuggling and will:

- Identify and prioritize techniques and methods for forensic analyses of non-nuclear materials associated with seized nuclear and radioactive materials in order to answer questions regarding geolocation and route attribution;
- Improve technical capabilities including collection and preservation of evidence, initial on-scene hazard categorization, assessment of nuclear materials composition, identification of applicable national law and statutes, and assistance to States with nuclear forensics as requested by identifying best practices;
- Formulate and execute interlaboratory exercises to evaluate and improve techniques and methods for forensic analysis of seized nuclear materials;

— Identify and prioritize techniques and methods for forensic analyses of nuclear materials in order to answer questions regarding sources and intended use of seized nuclear materials.

2. ITWG TERMS OF REFERENCE AND AFFILIATIONS

The ITWG is an informal association of practitioners of nuclear forensics. The terms of reference for the ITWG do not require sanctioning by any governmental or international body. The ITWG reports informally to the Nuclear Safety and Security Group of the G8 that recognizes the working group as the international collective for the best practice in nuclear forensics. The lack of a formal affiliation allows the ITWG to provide a tailored forensics response to requesting States without the complexities required by more formal endorsements or recognition.

The ITWG also works together with the IAEA. As identified by its own consultants' group, the IAEA can refer requesting States to the ITWG for international assistance in nuclear forensics investigations. An interested State contacts the IAEA to evaluate the need for nuclear forensics and to obtain information on, and access to, ITWG capabilities. The ITWG provides the IAEA with a point of contact for a spectrum of nuclear forensics assistance as well as a means to provide mutual assistance in nuclear forensics investigations.

3. MEETINGS AND ORGANIZATION OF THE ITWG AND ITS TASK GROUPS

The ITWG is open to all States interested in nuclear forensics. Each State funds its own participation; in certain instances, States can also request international assistance to underwrite their expenses. Since 1996, the ITWG has met annually at meetings hosted by participating states in Europe and the Russian Federation. Table 1 is a summary compilation of the meetings conducted to date. Each State sends its own delegation of technical and law enforcement representatives to the annual meeting as well as interested governmental representatives. Over the years, this approach has resulted in a mix of attendees some with collective knowledge garnered from attending several ITWG meetings and others who as new members bring fresh perspectives and insights to the group.

The work of the ITWG is overseen by an executive committee, represented by members of the European Commission, the USA, France, the United Kingdom and Hungary, and is presently performed in four task groups,

TABLE 1. SUMMARY AND LOCATIONS OF ITWG MEETINGS 1995–2007

Meeting	Location	Date
ITWG-1	Karlsruhe, Germany	31 Jan.–1 Feb. 1996
ITWG-2	Obninsk, Russian Federation	2–4 Dec. 1996
ITWG-3	Como, Italy	10–11 Jun. 1997
ITWG-4	London, United Kingdom	10–11 Jul. 1998
ITWG-5	Helsinki, Finland	9–10 Jun. 1999
ITWG-6	Vienna, Austria	8–9 Jun. 2000
ITWG-7	Luxembourg, Luxembourg	27–28 Jun. 2002
ITWG-8	Budapest, Hungary	1–2 Oct. 2003
ITWG-9	Cadarache, France	16–17 Jun. 2004
ITWG-10	Prague, Czech Republic	6–9 Jun. 2005[a]
ITWG-11	Speyer, Germany	26–29 Sep. 2006[a]
ITWG-12	Umeå, Sweden	25–28 Jun. 2007[a]

[a] Includes ITWG and ITWG Nuclear Forensics Laboratories (INFL) meetings.

each chaired by a task group leader, that are standing committees of experts dedicated to the needs of the international forensic community.

3.1. First responders task group

The first responders task group is dedicated to post-incident management with a focus on the collection and preservation of forensic evidence while balancing the need to protect law enforcement and criminalists working within a potentially radioactively contaminated crime scene. In addition to reviews of country specific experience in responding to incidents involving the presence of radioactive materials, the task group is proposing to develop a catalogue of previous national first responder exercises that include an element of nuclear forensics. The catalogue may include a description of the scenario and objectives without a discussion of results or specific capabilities.

3.2. Guidelines task group

The purpose of this task group is to develop consensus guidelines that can be referenced by analytical laboratories represented at ITWG meetings. The guidelines will provide a generalized approach to techniques, but will not be detailed laboratory procedures. The use of these guidelines will enable comparison of results among all of the ITWG laboratories, as well as ensure analytical results that can be best implemented to generate nuclear forensics evidence that can be used in the potential criminal prosecution of illicit trafficking cases in a court of law. Individual guidelines will be developed for analytical techniques specific to nuclear forensics analysis (e.g. measurement of trace element impurities) as well as for materials (e.g. analysis of low enriched uranium oxide nuclear fuel pellets) important to nuclear forensic investigations.

3.3. Communication and outreach task group

The key objective of this task group is to foster an "association of active practitioners of nuclear forensics" through the development of an international nuclear forensics community. To achieve this objective, regular communication with external organizations is a critical requirement. To this end, contacts were established with the European Network of Forensic Science Institutes (ENFSI), with the World Customs Organization (WCO), with EUROPOL and INTERPOL and, as noted above, close contact is maintained with the IAEA. The communications and outreach task group launched the ITWG web site [1] in 2004 that serves as a primary means of information exchange among ITWG participants. The secure web site includes information on the objectives, charter and organization of the ITWG; future meetings, past meeting reports and archived presentations; and access to ITWG reports and publications. Access to the web site is protected and may be arranged through a request to the ITWG executive committee.

3.4. Exercise task group

The forensic exercise task group designs and organizes both analytical and scenario based training aids to improve nuclear forensics response capability. This task group is responsible for conceiving the objective of the exercise, obtaining statements of capability of participating laboratories, scheduling the exercises with the international participants, arranging logistics to execute the exercises, collecting and collating analytical results, and disseminating all findings. As noted, the ITWG has already completed analytical exercises involving plutonium in 1998–2000 and high enriched uranium in 2000–2002 [2]. In these round robins, a representative nuclear sample was aliquoted equally, shipped to the participating laboratories and analysed for signatures (e.g. major and minor isotopes, fission products, major and trace elements, physical characteristics) as an unknown nuclear sample. Laboratories report results anonymously to allow for intercomparison. The purpose of the round robins is not to 'grade' individual laboratories in their performance but rather to learn as a community and participating laboratory from the results of a coordinated laboratory exercise conducted using a common sample. The exercise task group has planned a third analytical exercise for 2007–2008.

4. ITWG AND THE MODEL ACTION PLAN

Recent cooperation on the development and publication of the nuclear forensics model action plan underscores shared objectives of the IAEA and the ITWG to deter the illicit trafficking of nuclear materials. Soon after being founded, the ITWG conceived a model action plan for the recommended pursuit of nuclear forensics investigations. In 2003, the IAEA approached the ITWG about drafting a technical report that described the recommended approach to pursuing nuclear forensic investigations. Documentation of the model action plan includes recommendations concerning incident response to an interdiction event, collection of evidence in conformance with required legal standards, laboratory sampling and distribution of samples, radioactive materials analysis, including categorization and characterization of samples, forensics analysis of conventional evidence, and case development including interpretation of forensic signatures. The model action plan was published in 2006 by the IAEA [3] and has subsequently been adopted by many nations as they prepare and respond to incidents of illicit nuclear trafficking. The sharing of this comprehensive plan is a key component of global coordination in nuclear forensics.

Reference [3] offers those countries without the capability to do their own forensic analysis the ability to have such analysis carried out at a laboratory belonging to a member of the ITWG, with the IAEA acting in a brokering role to arrange the analysis. The ITWG offers the IAEA points of contact to advise and assist in nuclear forensics investigations.

5. ITWG MENU OF OPTIONS

Because each nuclear smuggling case is different, resulting nuclear forensic investigations must be tailored to the specific needs of each case. To enable this individual response, the ITWG has developed a 'menu of options' that allows group members to provide a specific response. Different assistance options include basic characterization to comprehensive technical studies that enable a full nuclear forensics characterization. Different laboratories offer unique capabilities; multi-laboratory versus single laboratory involvement may enhance confidence in the resulting nuclear forensics interpretation. A 'forensics management team' identified a priori can provide a point of contact in each country or nuclear forensics laboratory to facilitate evidentiary requirements, external communication and case development. Finally, the menu will specify the extent and timeline of a final nuclear forensics report.

6. ITWG NUCLEAR FORENSIC LABORATORIES

As the group has expanded, the need to provide a forum for in depth technical exchanges dedicated to the improvement of nuclear forensic analytical methods, application of signatures to nuclear forensic investigations, best execution of nuclear forensic analytical exercises and scenario based response drills has resulted in the creation of the ITWG Nuclear Forensics Laboratories (INFL) as a companion technical organization to house the scientific pursuits of the working group. The affiliate role of INFL has improved the technical practice of nuclear forensics and thereby directly benefited the national and international response in nuclear forensics. INFL is pursuing a relevant agenda including methods for reliable nuclear and radiological categorization of forensic samples, needs for reference materials in nuclear forensics, and measurement and interpretation of trace element signatures in diverse nuclear forensic applications.

7. RECENT ACTIVITIES

The past five years have seen a substantive growth in the membership and agenda of the ITWG. Each annual meeting draws larger numbers of participants; at the last meeting in Umeå, Sweden, 30 nations and organizations participated. In concert with the larger membership, the ITWG has evolved since its inception in response to the changing nature of the threat posed by nuclear trafficking. At each annual meeting, a critical part of the agenda is a review of the application of nuclear forensics in response to the unauthorized trafficking of nuclear contraband. Central to this endeavour is the review of country specific responses to illicit trafficking that incorporate requirements for nuclear forensics, radiation measurements and data interpretation to counter the threat of nuclear terrorism. Recent topics include experience in border and internal security incident response, lessons learned from forensics casework, evaluation of nuclear smuggling trends, developments of multinational partners in nuclear forensics, including the IAEA and the European

Commission, the need for nuclear forensics engagement with the international community, and companion policy and statutory developments that pertain to nuclear forensics to best address the threat from nuclear smuggling.

The ITWG is actively expanding its membership to regions affected by illicit trafficking of nuclear materials. A directive from the G8 is to increase its membership to States that are interested in developing their indigenous capability to deter illicit trafficking. Over the past years, nuclear forensics experts from Tajikistan, Kyrgyzstan, Kazakhstan and the Republic of Korea have attended the meetings for the first time. Furthermore, the addition of Russian–English language interpretation services has enabled scientists from the Russian Federation and newly independent States to fully engage in the technical discourse of the meetings. This has facilitated scientific exchange and enabled necessary collaborations with essential partners. While the ITWG holds its annual meeting at a central location, a recent proposal for distributed regional meetings convened in localities directly affected by nuclear smuggling offers additional benefits by extending nuclear forensics expertise to those that most need the assistance. This will ensure that information, knowledge, experiences and lessons learned are readily transferred.

The ITWG is active in outreach to inform the international community of the threat posed by illicit trafficking, the need to effectively prosecute these crimes and the capabilities available to collect evidence linking perpetrators to their nuclear contraband. In 2007, the ITWG provided a summary of its activities at a recent meeting of the G8's Nuclear Safety and Security Group (NSSG), participated in the International Nuclear Terrorism Law Enforcement Conference sponsored by the Global Initiative to Combat Nuclear Terrorism and was featured in a number of publications and nuclear security forums [4].

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HEU SEIZED IN JULY 2001 IN PARIS
Analytical investigations performed on the material[*]

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In mid-2001, French security services were informed that an individual was trying to sell high enriched uranium (HEU) in Paris; 30 kg were to be available within a couple of days. Although the person was a well known swindler, an operation involving the nuclear response team was decided upon and investigations were conducted in his apartment and garage, but no radioactive material was detected.

Informed by intelligence services of a possible meeting involving the swindler at Place de la Nation in Paris, the response team finally detected a radiological anomaly in a vehicle nearby. A lead container containing a radioactive sample was discovered and the man was arrested by the police.

The paper describes the analytical investigations performed on the 500 mg HEU oxide sample.

Isotopic analysis, impurity measurements, age determination and other physical and chemical characterizations of the oxide powder were performed with state of the art techniques to provide good accuracy and precision.

The glass ampoule, its lead container, the polyurethane foam as well as the yellow paraffin wax which were used to protect the ampoule were analysed in detail to provide further elements of origin.

Precise mass spectrometry provided the following atomic isotopic abundances: ^{234}U = 1.17 (±0.02)%, ^{235}U = 72.57 (±0.86)%, ^{236}U = 12.15 (±0.14)%, ^{238}U = 14.11 (±0.08)%. These values, along with the detection of

[*] The full paper was not available for publication. The synopsis appears in its place.

[**] With contributions from Centre d'Études de Valduc, Is-sur-Tille, Centre DAM Ile-de-France and Direction Sécurité et non prolifération, Bruyères-le-Châtel, France.

[***] Present address: Permanent Mission of France to the United Nations Organizations at Vienna, Austria.

traces of ^{232}U and ^{233}U, plutonium and caesium indicated that the material was irradiated in a reactor and then reprocessed.

The date of the latest chemical separation could be estimated as November 1994, with a 100 d uncertainty.

Very similar values were reported for the analysis of HEU interdicted in Bulgaria in May 1999. These two materials are likely to have the same origin.

Nuclear analytical laboratories in France are part of the International Technical Working Group on Nuclear Forensics (ITWG). In this context and as part of the presentation at the Conference, a film is to be shown showing our capabilities, which was prepared during one of the round robin exercises.

IAEA-CN-154/055

THE PROBLEM OF ILLICIT NUCLEAR TRAFFICKING IN GEORGIA

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Abstract

Georgia is a small country situated between the Black Sea and the Caspian Sea. Georgia borders the Russian Federation in the north, Azerbaijan in the east, and Armenia and Turkey in the south. Considering the important geographic position of the country and the volatile political situation of the region in which it is located, the problem of illicit trafficking of radioactive and nuclear materials represents a pressing issue for Georgia.

1. INTRODUCTION

Historically, Georgia has been positioned at the crossroads of the major east–west transportation routes. Thus, because Georgia is a transit country, many goods cross its territory. The fact that some of the neighbouring countries widely use nuclear and radioactive materials increases the likelihood of illicit trafficking of such materials. Another factor of concern is represented by orphan radioactive sources.[1] Unfortunately, there were several radiological incidents connected to such orphan sources [1]. Notable cases include the discovery of abandoned radioisotope thermoelectric generators (RTGs), which contain significant amounts of ^{90}Sr. The initial radioactive activity of each RTG was estimated at 35 000 Ci. Six such sources were found and safely stored. It

[1] More than 200 orphan sources have been discovered in Georgia.

should be noted here that RTGs are particularly well suited for terrorist purposes because they contain substantial amounts of ^{90}Sr, which can be used in the production of potent radiological dispersal devices (RDDs), more commonly known as 'dirty bombs'. The last RTG incidents occurred in late 2001 and early 2002, when three woodcutters received serious radiation exposure from two such sources, which they found in the mountainous Tsalendjikha district in the western part of the country (Fig. 1).

Another category of orphan radioactive sources that poses a public health risk is represented by Soviet era calibrating devices containing ^{137}Cs, which were used by Russian troops stationed on Georgian territory before the breakup of the USSR (Fig. 2). A number of such sources were found and an attempt to illegally transfer one such source abroad was prevented. The presence of orphan radioactive sources highlights the importance of enforcing strict radiation control at the borders of Georgia in order to prevent illegal transfers of nuclear and radioactive materials.

2. LEGISLATION AND REGULATORY INFRASTRUCTURE

Georgia became a Member State of the IAEA in 1997. Since then, Georgia has received substantial support and assistance from the IAEA and other countries to improve the level of radiation safety, and the import and export control of radioactive materials, in particular. The radiation safety system in Georgia is based on the framework legislation — the Law of Georgia No. 1674-IS On Nuclear and Radiation Security — which entered into force on 1 January 1999. This law (Article 8, Paragraph 1) designates the Ministry of

FIG. 1. Radioisotope thermoelectric generators (RTGs) found in the Tsalendjikha district, Georgia, in 2001.

FIG. 2. A typical container with a ^{137}Cs source found on a former Soviet military base in Georgia.

Environment and Natural Resources Protection of Georgia (MENRP) as the national regulatory body in the field of nuclear and radioactive activities and with this purpose the Nuclear and Radiation Safety Service (NRSS) is set up within MENRP (Article 8, Paragraph 2). The export and import control of radioactive sources is regulated by a special system of licences and permits, which is based on the framework legislation — the Law of Georgia No. 1775-RS On Licences and Permits — adopted on 24 June 2005. Every import and export of a non-exempted (or cleared) source must be approved by a special permit issued by MENRP. Such a permit is based on the conclusion of the NRSS. At the same time, by law, any export, import or transit of radioactive waste via the territory of Georgia is strictly prohibited (Article 41). Georgia is stepping up efforts to implement the IAEA requirements set forth in the Guidance on the Import and Export of Radioactive Sources [2]. To achieve this goal, the draft of the Law of Georgia On Transportation of Radioactive Goods was prepared and its text has already been approved by the different government ministries and agencies. The draft is now awaiting adoption by the Parliament of Georgia. Based on this law, the special rules and norms should be further elaborated for the transport of radioactive materials. Some of these implementing regulations have already been drafted.

3. PROBLEM OF ILLICIT TRAFFICKING OF RADIOACTIVE AND NUCLEAR MATERIALS IN GEORGIA

Georgia possesses no nuclear facilities with the exception of a low power (0.9 W) subcritical assembly, which functions at the E. Andronikashvili Institute of Physics. The assembly contains 660 g of 36% enriched uranium. In the past, Georgia only had one research reactor, IRT-M, which was dismantled and all fuel (both fresh and used) was transferred abroad as part of the 'Auburn Endeavor' operation in 1988. The reactor core was entombed in a special concrete sarcophagus, and, as a result, the entire facility was transformed into an intermediate state that does not demand special control and supervision, while its radiation safety and nuclear security are guaranteed even in extreme situations. The reactor is currently undergoing decommissioning, which is being carried out by IAEA technical cooperation project GEO/3/002.

As was mentioned earlier, Georgia's status as a transit country and the situation with regard to orphan nuclear and radioactive sources increase the threat of illicit trafficking of nuclear and radioactive materials. In recent years, there were several attempts to use the territory of Georgia for the illegal transfer of nuclear materials abroad, including the following:

- On 20 September 1999, the Ministry of State Security operatives detained individuals with 219 capsules containing 16% enriched ^{235}U with a total weight of 1000.7 g;
- On 21 April 2001, 920 g of 3% enriched ^{235}U was seized;
- On 18 July 2001, 1581 g of 5% enriched ^{235}U was seized;
- In late 2006, 100 g of 90% enriched ^{235}U was seized.

The Georgian authorities pay special attention to the illegal movement of radioactive sources that can be used for the production of dirty bombs. With support from the IAEA and the US Department of Energy, special training seminars were organized for frontline personnel, including border guards and customs officials. The materials used in such training are based on IAEA TECDOCs 1311, 1312 and 1313 [3–5], and on the case studies of relevant incidents that took place at the border crossings of Georgia and other countries. A special practical guide book for border guards and customs officials was also issued recently. In addition, a programme to equip checkpoints with radiation control equipment is currently under way. In the context of this border defence assistance programme, special portal monitors (with gamma and neutron detectors as well as video cameras) are being installed at checkpoints along the borders of Georgia. The portable equipment, including dosimeters and spectrometers, is also being distributed among the border guards and customs officials. The aforementioned portal monitors can easily detect an increase in the gamma or neutron radiation, as illustrated in the printout produced by one such monitor during a recent incident (Fig. 3). The portal monitor charts the distribution of gamma and neutron radiation in a truck or a railcar, which helps with pinpointing the precise location of the source.

One of the best illustrations of the efficiency of portal monitors was the seizure of highly radioactive plutonium–beryllium industrial radiography sources in a scrap metal shipment en route to Germany at the Red Bridge port of entry on the Georgia–Azerbaijan border (Fig. 4).

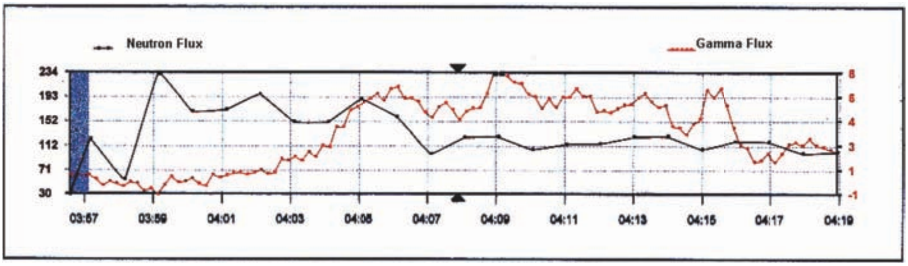

FIG. 3. Printout from a portal monitor showing the distribution of gamma and neutron radiation in a truck passing through the border checkpoint (plotted against the time of movement on the horizontal axis).

FIG. 4. Plutonium–beryllium source found in a scrap metal shipment at the Red Bridge port of entry on the Georgia–Azerbaijan border.

4. CONCLUSION

Georgia's geopolitical situation makes it a lucrative destination from the point of view of illicit trafficking of nuclear and radioactive materials and, therefore, with international support, the Government of Georgia must redouble efforts to strengthen the second line of defence at its borders.

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THE 2003 AND 2006 HIGH ENRICHED URANIUM SEIZURES IN GEORGIA
New questions, some answers and possible lessons

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Abstract

An analysis of the two most recent nuclear trafficking incidents involving high enriched uranium (HEU) — the seizure of 80 g of HEU in Georgia in 2006 and 170 g of HEU on the Georgian–Armenian border in 2003 —demonstrates that these incidents share some features with cases in the early 1990s: the trafficking appears to be supply driven, the material involved is of Russian or suspected Russian origin, and no end-users or actual buyers were identified or apprehended. At the same time, the 2003, 2006 and other recent incidents demonstrate new features: the involvement of middlemen, smaller quantities of material seized, material marketed as samples, the use of 'vintage' contraband from relatively old stocks, and 'Muslim countries/organizations' named by the culprits as intended destinations. Investigations of the two HEU seizures in Georgia were complicated by lack of transparency and poor international cooperation, particularly in the 2006 incident; problems with timely reporting of the incidents to the IAEA; and the apparent interference of political factors in the timely investigation and reporting of the two incidents. As a result, questions remain about such basic facts as the amount and characteristics of the material, its origin, the names and background of accomplices, transport routes and the whereabouts of additional quantities of the contraband. The paper provides recommendations on information collection and sharing on nuclear trafficking, and argues that reliable mechanisms for international cooperation in the investigation of nuclear smuggling cases still need to be established.

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1. INTRODUCTION

Until very recently, the conventional wisdom in the non-proliferation community has been that the theft and smuggling of proliferation significant nuclear materials in the newly independent States have declined significantly thanks to major improvements in securing these materials. However, the seizure of 80 g of high enriched uranium (HEU) in Georgia in 2006 and 170 g of HEU on the Georgian–Armenian border in 2003 could be a sign of a possible resurgence of nuclear smuggling in the newly independent States.

The majority of confirmed thefts and smuggling cases involving HEU and plutonium (Pu) occurred between 1991 and 1995, immediately after the collapse of the Soviet Union and prior to the introduction of security and control upgrades at nuclear facilities. The incidents from this period shared several common characteristics. They typically involved low or mid-level employees who were amateurish opportunists trying to make extra cash. The perpetrators were usually caught in the process of trying to find a buyer for the material, often as the result of sting operations. The majority of the smuggling operations during this period involved the movement of material westward. None of the significant cases of the period involved organized criminal groups or terrorist organizations in the trafficking of materials that could be used for weapons.

From 1996 until mid-1999, no significant incidents involving materials that could be used for weapons were officially reported and listed in the IAEA table of illicit trafficking incidents involving HEU and Pu. The Center for Nonproliferation Studies (CNS) database records two cases for this period, though one of them is difficult to attribute to a specific date and the other is not sufficiently corroborated.

The first case involves the disappearance of up to 2 kg of HEU (90% ^{235}U) from the Physics and Technology Institute in Sukhumi, Georgia, sometime between 1992 and 1997.[2] A civil war in Abkhazia prevented access to this institute by Russian and/or international nuclear inspectors until 1997; after Russian representatives finally visited the institute, they could not locate the HEU that was recorded in a 1992 inventory. To date, the HEU has not been recovered and its whereabouts remains unknown [1].

One other case was reported by the Russian media in December 1998 and involved the attempted theft of 18.5 kg of nuclear material, possibly HEU, from a nuclear facility in Chelyabinsk Oblast, Russian Federation. The case is

[2] The first incident may not have been reported to the IAEA because of the continuing dispute over the territory of Abkhazia where the facility is located.

potentially significant because of the large amount of material involved and the alleged engagement of an organized group of facility employees in the diversion attempt. However, the veracity of this incident is uncertain.[3]

Aside from the two cases mentioned previously, the absence of confirmed nuclear trafficking incidents during the period 1996–1999 may be indicative of improved security at Russian and post-Soviet facilities. Alternatively, the apparent lull could instead be the result of more sophisticated smuggling techniques, the use of new smuggling routes — including those used for drugs and weapons trafficking — and the reluctance of national governments to publicize facts pertaining to a continuation of illicit nuclear trade. Some analysts, for example, have argued that the amateurish 'visible' nuclear black market may be a poor indicator of the entire market place, a significant portion of which may have escaped detection [2].

The seizure of 4 g of HEU (72% ^{235}U) in May 1999 on the Bulgarian–Romanian border, and several other subsequent incidents, involved very small quantities of fissile material and were not widely regarded as indicators of a new wave of trafficking incidents. A more noteworthy case during the post-1999 period involved the seizure of 0.5 g of HEU (72% ^{235}U[4]) in July 2001 in Paris, France. The three individuals apprehended in the Paris case belonged to a criminal group and one of them had documents related to travel to the former Soviet republics. The contraband reportedly was practically identical in its enrichment level and composition to the HEU recovered in Bulgaria in 1999. Both materials also appear to have transited through Moldova [3].

Most analysts have treated the Paris case as an aberration to the general downward trend in illicit nuclear trafficking. More difficult to dismiss are the two seizures of HEU in Georgia in 2003 and 2006. These cases are disturbing on several grounds, particularly that they signal continuing shortcomings in the control, accounting and protection of fissile material in the States of the former Soviet Union. They also involve larger amounts of very highly enriched uranium than many of the earlier cases. The 2006 incident also indicates that some material, perhaps diverted from post-Soviet nuclear facilities many years

[3] The incident has not been officially confirmed. In addition, it was reported by a local Federal Security Service (FSB) head on the eve of Secret Service Day and could have been a self-aggrandizing speech rather than a report on a real case. The bragging officer allegedly was reprimanded for the disclosure. For a detailed discussion about the validity of this case, as well as an interpretation of some other significant cases, see Ref. [1], pp. 112–120.

[4] Original reports claimed that the material was almost 80% ^{235}U.

ago, remains in circulation.[5] Unfortunately, the Russian Federation has not completed a comprehensive physical inventory of fissile material, and only a small number of facilities have complied with Russian regulations in this regard.[6] While the improvements to the materials protection, control and accounting (MPC&A) system accomplished in the last decade and a half, particularly in the area of physical protection, are significant, some amount of fissile materials may have gone missing in the early and mid-1990s.

The 2003 and 2006 seizures of HEU in Georgia also raise serious concerns about the international mechanisms for the response to and investigation of such incidents. They suggest, for example, that meaningful intelligence sharing about illicit nuclear trafficking remains at best inadequate, despite repeated US–Russian summit pronouncements to the contrary. Cooperative measures to prevent, investigate, prosecute and punish are still inadequate. While much remains to be learned about the two HEU cases, some preliminary conclusions can be drawn from media reports, official statements, and interviews conducted by the authors and other CNS staff members.

2. JUNE 2003 SEIZURE OF HEU IN GEORGIA

On 26 June 2003, Georgian border guards arrested a man possessing 170 g of HEU (~90% ^{235}U) at the Georgian–Armenian border. The Armenian smuggler, Garik Dadayan, had travelled from the Russian Federation to Armenia via Georgia and was arrested at the Sadakhlo checkpoint on the Georgian–Armenian border. Apparently, he had crossed the Russian–Georgian border without any problems a day earlier at the same crossing subsequently employed by the culprit in the 2006 HEU smuggling case.[7] The driver of the car hired by Dadayan later testified to providing regular shuttle

[5] Some earlier cases involving LEU suggest that the quantities of the material diverted in the early to mid-1990s could be significant and thefts may have gone undetected to this day. For example, when LEU was seized from the Balashikha criminal group in the Russian Federation in December 2001, the Russian authorities revealed that the material involved was stolen from a nearby Elektrostal facility in the mid-1990s.

[6] CNS staff interviews with a Russian MPC&A expert, Mar. 2007.

[7] The Upper Lars or Kazbegi crossing between Georgia and the Russian Federation is on one of the main roads connecting the Russian Federation, Georgia and Armenia.

services between Vladikavkaz (Russian Federation), Tbilisi (Georgia) and Yerevan (Armenia) using his personal car.[8]

During the crossing of the Sadakhlo checkpoint, the car in which the smuggler was travelling triggered a radiation detector alarm. The border guards asked each passenger to take his/her belongings and go through individual radiation screening. At this point, Dadayan dropped a plastic bag and tried to leave it behind but a border guard noticed it and asked him to pick it up. Not surprisingly, the bag triggered an alarm and when the bag was opened, the guards found a small tin container for loose tea. The box had three vials inside with dark grey or black powder (witness accounts of the exact colour vary). Reportedly, one of the border guards tried to lick the power and then spat it out after he realized it was not a drug. Dadayan was apprehended but other passengers were allowed to go free. Dadayan's purse, however, was left in the car. As it turned out, it contained his passport, airplane tickets, and notes about various chemicals and materials for nuclear weapons applications, including the uranium oxide formula (U_3O_8), and a price list for some of these materials.

Dadayan denied that the nuclear material belonged to him. However, while still in custody at the checkpoint, he contacted some of his relatives and acquaintances, and asked for assistance to get him out and to transport the material to Armenia. Allegedly, he offered \$30 000 for transporting the material. Two of his acquaintances and witnesses in the case (one Armenian and one Georgian) whom he called and who came to Sadakhlo, refused to help him when they learned that the material was a radioactive substance.

A rather murky part of the case involves so-called 'red mercury'. During the investigation, one of the witnesses, Tamaz Tikanashvili, a Georgian national, claimed that he had wanted to acquire some 'red mercury'. In June 2003, according to him, one of his friends, also a Georgian national, called and informed him that he had met Dadayan, who could bring some 'red mercury' to Georgia. Apparently, Dadayan called Tikanashvili from Sadakhlo as well. According to Tikanashvili, when he learned that Dadayan had been arrested because he tried to bring a radioactive material to Armenia and that the material was not intended for him, he refused to help Dadayan and left the crossing. He claimed that he was only interested in 'red mercury'. It is unclear whether Georgian authorities followed up on this information and investigated

[8] The details of the arrest and investigation of the 2003 HEU seizure are based on the testimonies and results of an investigation included in the court verdict (Case No. 1-323, 2004, Court of Kentron and Nork-Marsh, Yerevan, Armenia).

why he was interested in this substance, which is often peddled by con artists as bomb grade nuclear material.

Dadayan purportedly tried to sell the HEU, which he claims he obtained from Novosibirsk, to a Turkish 'middleman' by the name of Teimur Sadik, who Dadayan said planned to provide it to 'a Muslim man'. Sadik reportedly was in custody for a period of time in Turkey [4] , but his current status is uncertain. The authors have been unable to ascertain whether US Government representatives ever interviewed Dadayan or Sadik.

Ultimately, Dadayan was turned over to the Armenian authorities and was tried and sentenced to two and a half years in prison; he was released after about a year and a half. The reasons for the light sentence and early release were, reportedly, poor health related to his war service in Nagorno-Karabakh, the fact that he has three children[9] and his reported friendship with high level Government officials in Armenia. He now appears to be free in Yerevan.[10]

It is interesting to note the fact that the 2003 case involved HEU only became publicly known in September 2005, when the IAEA provided an updated table of incidents involving HEU and Pu. Before this revelation, even an unclassified version of the US Department of Homeland Security database listed it as a case involving uranium of "unspecified enrichment". It appears that none of the countries involved in the case — Armenia, Georgia and the Russian Federation — reported the details to the IAEA in a timely manner. The USA was informed about the case early on and apparently was in possession of the material by October 2003 (at Lawrence Livermore National Laboratory) but also delayed provision of details to the IAEA.

The Russian authorities also received a sample of the material seized in 2003. The exact results of the Russian analysis are not known to the authors, however, it appears that the material consisted of two different batches. One was 70 g; the other was 100 g. The material was in two different forms — UO_2 and U_3O_8.[11]

The New York Times article that broke the news of the 2006 seizure of HEU in Georgia also provided some additional information about the 2003 case [4]. According to the article, Georgian officials claimed the uranium had come from Novosibirsk, the city that houses the largest fuel fabrication facility in the Russian Federation and handles "vast quantities of highly enriched

[9] A response by the Ministry of Justice of the Republic of Armenia to a request from the Institute of Reporting on War and Peace to provide information about the sentence of Garik Dadayan.

[10] Authors' communication with journalists from the region.

[11] Authors' discussions with US and international experts.

uranium”. In addition, it sites Pavlenishvili, a Georgian investigator, as saying that the Russian secret services confirmed at least two trips by Dadayan to Novosibirsk.

The Novosibirsk Chemical Concentrate Plant, which manufactures nuclear fuel for various purposes, including HEU fuel for research and other reactors, is located in Novosibirsk, Russian Federation. Several cases of loss and theft of nuclear material from the Novosibirsk Plant in the 1990s are recorded in the newly independent States nuclear trafficking database maintained by CNS [5]. Nuclear MPC&A upgrades were undertaken at the Novosibirsk facility with assistance from the USA during the post-2000 period. According to some Russian experts, MPC&A upgrades completed at the Novosibirsk Chemical Concentrate Plant in 2004 are the most comprehensive among Russian civilian nuclear fuel cycle facilities.[12]

3. 1 FEBRUARY 2006 HEU SEIZURE IN GEORGIA

The 1 February 2006 seizure of almost 90% enriched uranium in Georgia was confirmed by the Georgian authorities in media interviews almost a year later. The revelations were immediately followed by articles published by the New York Times and the Associated Press on 25 January 2007 [6]. Later comments by Russian, Georgian and US officials, and experts were often of a confusing nature, and provided inconsistent and sometimes misleading information. Mutual accusations of non-cooperation by Russian and Georgian officials also impeded the sorting of facts from fiction with regard to this incident.

Many details regarding the 2006 case are still missing. The trial of the main culprit and his accomplices was held behind closed doors, and the materials of the case remain classified. The very incomplete description that follows is an attempt to reconstruct the incident, drawing upon data from open sources, personal interviews and correspondence with various authorities in the region.

The incident in question unfolded in the period between late 2005 and February 2006. On 1 February 2006, Oleg Khintsagov, a 50 year old Russian citizen residing in North Ossetia (Vladikavkaz), Russian Federation, who was a petty trader of foodstuffs, was apprehended in Tbilisi, Georgia, along with three Georgian accomplices as the result of a sting operation carried out by the Georgian special police unit. A Turkish speaking Georgian undercover agent,

[12] Authors’ interview of a Russian MPC&A expert (Mar. 2007).

reportedly representing himself as a member of a 'respectable Muslim organization' made contact with Khintsagov, who claimed he had 2–3 kg of HEU and demanded $100 million for the material. Khintsagov wanted to conduct the transaction in North Ossetia, but was lured to Tbilisi by Georgian police for the conclusion of the deal. According to most press reports, when apprehended, he had about 100 g[13] of 90% HEU in two plastic bags in his jacket pockets.

Khintsagov reportedly entered Georgia from North Ossetia through the Upper Lars–Kazbegi checkpoint, the same crossing used by Dadayan in 2003. Khintsagov's cousin, Miron Gabarayev, who until July 2004 worked at the North Ossetian customs, reportedly aided him in crossing the border using his contacts at customs.[14] The two men apparently had crossed the border on a number of previous occasions, including on 31 January 2006 — one day before the arrest.[15] When the story first appeared in January 2007, Russian customs representatives claimed that the Upper Lars crossing is equipped with Yantar radiation detection equipment and that the material should have triggered the alarm [7].

The 2006 HEU seizure only received major press coverage a year after it actually occurred. However, there were already several reports alluding to the case in February 2006, though they failed to provide detailed information. For example, there were reports in early February about a press conference held by Russian Defence Minister Sergei Ivanov in Munich on 5 February 2007, when he blamed Georgian authorities for fuelling Russian–Georgian tensions through their 'speculative' accusations. He denied allegations that a Russian resident with 80 g of HEU had been apprehended by Georgian authorities on the grounds that if the man indeed had carried this amount of HEU on his person he "would have been dead by now".[16] It remains unclear precisely how much HEU was retrieved from Khintsagov. Although the initial reports in early 2006 use the figure of 80 g, most of the stories in late January 2007 refer to

[13] See the discussion later in the paper about the amount of HEU seized.

[14] In his article [7], Felgengauer draws heavily on an FSB memorandum written in May 2006 that contains some details of the case and the results of the HEU analysis. A facsimile of the cover document is provided as an illustration in the published article. In a subsequent article [8], Felgengauer claims he received a copy of the FSB memorandum by fax from Tbilisi.

[15] According to the FSB memorandum cited by Felgengauer, they had already crossed the border at the Upper Lars crossing four times (14 Sep. and 11 Dec. 2005, and 4 and 31 Jan. 2006).

[16] It should be noted that carrying unirradiated HEU is not a great health risk. For the Ivanov quotation, see Ref. [9].

100 g. The IAEA table, which presumably is informed by information provided (albeit belatedly) by Georgian officials, uses the figure of 79.5 g.

In his initial testimony, Khintsagov reportedly claimed to have acquired the material in Novosibirsk, and maintained that he had access to another 2–3 kg of similar quality HEU at his apartment in Vladikavkaz, the capital of North Ossetia [10]. However, he later denied this information and stopped cooperating with the investigation. The claim that there was additional HEU at his apartment has not been confirmed; the degree to which it was ever investigated is not clear.

Khintsagov was convicted at a secret trial and sentenced to eight and a half years in prison, while his accomplices received lesser prison terms (between four and five years). Georgian officials have thanked the CIA, FBI and US Department of Energy (USDOE) for their assistance in the investigation, and some reports suggest that the CIA may have been involved in the planning of the sting operation [11].[17] Several sources mention that the FBI was involved in the investigation and the USDOE in the analysis of the material.

The sting apparently was triggered by information from Georgian sources in South Ossetia that some parties in the region were offering nuclear contraband for sale. During the period 2003–2005, Georgian authorities on several occasions publicly raised concerns about the trafficking of WMD, particularly nuclear and radioactive materials, through the territories of the two separatist regions of Abkhazia and South Ossetia. The status of these regions has been a point of contention between Georgia and the Russian Federation for almost 15 years.

These areas undoubtedly have provided a safe haven for illegal businesses, including smuggling operations involving conventional arms, narcotics and other illicit commodities. Less compelling are claims by Georgian authorities that the two regions have been actively used for nuclear smuggling. More specifically, in July 2005, the head of the Nuclear and Radiation Safety Service of the Georgian Ministry of Environmental Protection and Natural Resources, Soso Kakushadze, stated that there had been four attempts to smuggle HEU through Georgia between 2002 and 2005, and suggested that there were reasons to believe the material had travelled through South Ossetia [12, 13]. This statement appears to exaggerate the scale of illicit activities involving nuclear and radioactive materials in the region, unless there are indeed additional incidents that have not been reported publicly to date.

It should be noted that there is no evidence, as far as we can tell, to suggest that either the 2003 or 2006 smuggling incidents involved transporting

[17] Ref. [11] and authors' interviews with journalists in the region.

nuclear material in these separatist regions. Instead, the perpetrators in both cases appear to have followed a route along the main transportation artery connecting the Russian Federation and Georgia; this route does not cross either Abkhazia or South Ossetia. The only tie to South Ossetia in the 2006 case is the reported use of the territory of the separatist republic for gathering information about individuals who may have access to nuclear and radioactive materials for illegal sale. Georgian secret agents reportedly learned about the ‘seller’ from Vladikavkaz in South Ossetia [14]. While the separatist regions continue to be of concern, therefore, media reports on the HEU incidents claiming that the material was smuggled through the territory of one of these regions are incorrect.

Georgian officials stated in early 2007 that Russian secret services and authorities refused to be of assistance in the investigation of the 2006 HEU incident. As the reports cited above suggest, however, Russian secret services visited Tbilisi in February 2006 and held a meeting with Georgian authorities on 15–17 February 2006. At that time, they were given samples of the seized material. According to a representative of the Ministry of Internal Affairs of Georgia, 2 g of samples were provided to the Russians [10].[18] Russian secret services also appear to have interviewed Khintsagov [7, 15].[19]

Russian expert analysis of the HEU seized in 2006 indicated that it was significantly different from the 2003 material, both in terms of its composition and last processing date [7]. The analysis established that the material is 89.38% ^{235}U powder (U_3O_8) and that it was last chemically processed more than ten years ago. However, the analysts claimed they could not establish the exact origin of the material, and claim it could have come from a wide variety of Russian and foreign nuclear facilities. Most likely, it comes from a facility that has a chemical reprocessing line for U_3O_8 of 90% enrichment. While the enrichment level is close to the 2003 case, the analysts claim that the material is different from the HEU seized in 2003. The memorandum cited by Felgengauer indicates that the authorities requested additional quantities of the material for further analysis and also requested that Georgian authorities send an official investigation request to the Russian Prosecutor’s Office and provide available documents regarding the investigation of the case.

Georgian officials only went public with the case following prodding from the IAEA in late 2006, when the IAEA indicated that it planned to include the

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[18] Interview with Shota Utiashvili, head of the Information-Analytical Department of the Ministry of Internal Affairs of Georgia, http://www.svobodanews.ru (accessed on 2 Feb. 2007).

[19] Refs [7] and [15] and authors’ interviews with journalists in the region (Jan. 2007).

incident in its report of 2006 trafficking cases. Neither the USA nor the Russian Federation have provided the IAEA with any information regarding the smuggling incident, although both countries were sent samples of the material by Georgia, and both identified the material as almost 90% HEU. As such, one might argue that neither the USA nor the Russian Federation nor Georgia provided full, accurate and timely reports to the IAEA of nuclear trafficking developments.

Although US analysts cannot verify the material's origin, the characteristics of other uranium isotopes in the material persuade them that it is most likely of Soviet–Russian origin. T.B. Cochran, cited by the New York Times, said that the analysis performed by a US Government laboratory disclosed, among other things, traces of two rare forms of uranium, ^{234}U and ^{236}U, and suggested that this "provides 'a strong case' that it indeed came from Russia" [4]. Although not publicly acknowledged, all of the material is believed to have been moved out of Georgia to the USA.[20] Were this not the case, Georgia would be required to have the material under IAEA safeguards. Given that US national laboratories appear to hold HEU from both the 2003 and 2006 seizures, they are in a position to conduct a comparative analysis of the two batches and, at a minimum, could establish whether the material has the same origin.

4. CONCLUSIONS

It is too early to draw definitive lessons from the 2003 and 2006 HEU incidents, key aspects of which remain uncertain. However, some of the features these cases — along with other post-1999 incidents involving HEU and Pu seizures — have in common can be discerned, as follows:

- Four out of seven post-1999 HEU and Pu incidents involved Georgia;
- The materials seized were usually marketed as samples. Those peddling the materials indicated that larger amounts were available;
- In three cases, the so-called 'separatist' regions were involved in some way (points where borders were crossed or sites of marketing or purchase);
- Typically, only middlemen have been implicated. Neither the thieves nor the end-users have been identified or arrested;

[20] Authors' interviews during the Preparatory Committee for the 2010 Non-Proliferation Treaty Review Conference held in Vienna 30 April–11 May 2007.

— ‘Muslim countries/organizations’ are suspected destinations. Among alleged destinations, Turkey and Iran are most often named by apprehended smugglers;[21]
— In several cases, the contraband is ‘old’ (stolen or otherwise acquired in the early to mid-1990s).

It is extremely difficult working with ‘open sources’ to piece together an accurate chronology of events for the 2003 and 2006 Georgian cases. CNS staff discussions with various US Government, Georgian Government and IAEA authorities suggest that significant gaps in knowledge and inconsistencies regarding key elements of the smuggling incidents also characterize official accounts. Contributing to the ‘Roshomon’ portrayal of the cases are:

(1) Ignorance on the part of journalists reporting on the cases, confounded by misstatements and misrepresentations by various Government spokespersons;
(2) Efforts to deflect criticism of national nuclear security practices;
(3) Broader political disputes and mistrust among the protagonists (especially pronounced between the Russian Federation and Georgia — although this factor did not appear to be as much in evidence regarding Russian–Georgian cooperation on the 2003 case);
(4) Possible violations of IAEA safeguards and early notification requirements;
(5) Ongoing sting operations and a reluctance to compromise them;
(6) A desire not to embarrass other principals;
(7) Lack of meaningful intelligence sharing on trafficking cases between the USA and the Russian Federation;
(8) A failure to undertake extended interviews with all relevant suspects;
(9) The absence of a comprehensive database of prior smuggling pathways, players and material based on in depth comparative analyses;
(10) Efforts to convey the impression that facilities and borders are more secure and interdiction efforts more effective than merited;
(11) The absence of a central archive or repository of information on the different cases in Georgia and reported rivalry between the organizational actors involved in the 2003 and 2006 cases;

[21] In addition to the 2003 HEU incident, Turkish nationals also feature prominently in several post-1999 incidents involving LEU and radioactive materials.

(12) Genuine difficulties in obtaining conclusive evidence regarding the motivations and behaviour of the nuclear material suppliers, middlemen and end-users.

One or more of these factors help to explain the wildly divergent accounts offered at various points in time by different official and unofficial Georgian, US, Russian and IAEA sources. For example, according to some accounts, the secret services of the Russian Federation and/or Georgia actually control or manipulate trade in nuclear and radioactive materials in order to identify potential customers and brokers, as well as possible trafficking routes [7]. While some Georgian officials claim that information about the 2006 case was released to the public when they became frustrated about the lack of cooperation on the part of Russian officials, the Russian authorities attribute the publicity to efforts by the Georgian leadership to gain political leverage vis-à-vis the Russian Federation. Neither party, however, has publicly explained why the IAEA was not informed in a timely fashion about the details of the case, while the USA has not indicated why it continues to deny IAEA requests for information related to their analyses of the nuclear material.

As a consequence of this lack of transparency and poor international cooperation, questions remain about even such basic facts as the dates of the 2006 incident, the amount and characteristics of the material (there are reported discrepancies in the Russian and US analyses of the material); the names and backgrounds of the accomplices, the origin of the material and the transport route to Vladikavkaz; and the potential existence of an additional 2–3 kg of contraband. Similar questions persist with respect to the 2003 case and include the motivations of and modalities employed by Dadayan, the whereabouts of the Turkish middleman (Teimur Sadik) to whom Dadayan allegedly planned to sell the material, and the intended ultimate end-user.

Five years ago, in seeking to assess what was new and true in the domain of nuclear trafficking, the authors identified a number of positive developments that had been made in open source data collection, but also noted shortcomings regarding the lack of transparency and information sharing among governmental agencies, international organizations and academic or NGO research centres [1]. At that time, it was also noted that while meaningful intelligence sharing, especially between the USA and the Russian Federation, was vital to fill in gaps in data regarding past nuclear trafficking cases, actual cooperation had been minimal despite repeated pledges to cooperate. In addition, a plea was made to reassess and revise prior data on cases as new information became available. All of these recommendations remain valid today, as it is not evident that the deficiencies noted in 2002 have been remedied.

To some extent, the ability to make progress in correcting these shortcomings is a function of international political relations between the USA and the Russian Federation. In this regard, it is worth recalling that even during the most difficult periods of the Cold War, the USA and the Russian Federation worked closely together to combat a common danger — the threat of nuclear weapons proliferation. There is no good reason why today a similarly shared threat — the danger of non-State actors acquiring nuclear weapons — should not lead to greater cooperation in the sharing of intelligence information about illicit nuclear trafficking. What is needed is not more pronouncements on this theme at summit meetings, but concrete action. A good starting point would be the sharing of forensics information and evidence about the sources of material seized in the 2003 and 2006 Georgian cases.

Much easier to accomplish is the initiation of a systematic and comprehensive comparative analysis of all of the major nuclear trafficking incidents since 1991. It is simply scandalous that such an assessment, including interviews with those individuals who have been convicted of trafficking, has not been undertaken by any national government or international organization. One useful, if very incomplete, step in that direction would be for the IAEA or the USDOE to commission unclassified outside studies of some of the more interesting historical cases (for example, St. Petersburg in 1994; Chelyabinsk in 1998; Paris in 2001; Georgia in 2003 and 2006) with national government experts as commentators on the non-governmental expert presentations. Such an activity would have the dual utility of increasing information sharing while contributing to our collective understanding of prior nuclear trafficking incidents. Table 1 provides a summary of relevant confirmed proliferation incidents.

TABLE 1. SUMMARY OF CONFIRMED PROLIFERATION SIGNIFICANT INCIDENTS OF HEU AND PU TRAFFICKING IN THE NEWLY INDEPENDENT STATES (1991–2006)[a]

Case name, date of diversion	Material diverted	Origin of material	Recovery of material
Podolsk, 1992-05–1992-09	1.5 kg of 90% HEU	Luch Scientific Production Association, Podolsk, Russian Federation	1992-10-09: Russian police operation intercepted the smuggler, an employee of Luch facility, in Podolsk train station
Vilnius, Lithuania, early 1992	About 100 g of 50% HEU	Institute of Physics and Power Engineering, Obninsk, Russian Federation	1993-05: Approximately 100 g of HEU discovered in Vilnius bank vault embedded in portions of a shipment of 4 t of beryllium
Andreyeva Guba, 1993-07-29	1.8 kg of 36% HEU	Naval base storage facility, Andreeva Guba, Russian Federation	1993-07-29: Russian security forces arrested the thieves before they could smuggle the material out of the Russian Federation
Tengen, unknown	6.15 g of ^{239}Pu	Unconfirmed; possibly Arzamas-16, Russian Federation	1994-05-10: Police, in suspect's apartment for another reason, stumbled upon the cache of plutonium
Landshut, unknown	800 mg of 87.7% HEU	Unconfirmed; likely Obninsk	1994-06-13: Undercover German police acted as potential customers in a sting operation
Sevmorput, 1993-11-27	4.5 kg of 20% HEU	Naval shipyard, Sevmorput, Russian Federation	1994-06: The brother of a suspect asked a co-worker for help finding a customer. The co-worker notified authorities

For footnotes see end of table.

TABLE 1. SUMMARY OF CONFIRMED PROLIFERATION SIGNIFICANT INCIDENTS OF HEU AND PU TRAFFICKING IN THE NEWLY INDEPENDENT STATES (1991–2006)[a] (cont.)

Case name, date of diversion	Material diverted	Origin of material	Recovery of material
Munich, unknown	560 g MOX fuel; 363 g of ^{239}Pu	Unconfirmed; likely Obninsk	1994-08-10: Undercover German police acted as potential customers in a sting operation. In a related seizure in July 1994, German police had seized a small sample of plutonium–uranium MOX powder
Prague, unknown	2.7 kg of 87.7% HEU	Unconfirmed; likely Obninsk	1994-12-14: Anonymous tip to police giving the material's location (a parked car). In two instances in June 1995, Czech authorities recovered small additional amounts of HEU believed to be from the same source
St. Petersburg,[b] unknown	3.05 kg of 90% HEU	Unconfirmed; likely Machine Building Plant, Elektrostal, Russian Federation	1994-06-08: Russian news agencies report that in March 1994, Russian Federal Security Service agents arrested three suspects attempting to sell about 3 kg of HEU. Russian officials have confirmed the incident.
Prague, unknown	0.415 g of 87.8% HEU	Unknown	1995-06-06: A HEU sample was seized by police in Prague, Czech Republic
Ceske Budejovice, unknown	16.9 g of 87.8% HEU	Unknown	1995-06-08: A HEU sample was seized by police in Ceske Budejovice
Moscow, May 1994	1.7 kg of HEU	Elektrostal	1995-06-08: In a sting operation, Russian Federal Security Service agents arrested three suspects trying to sell HEU, one of whom was an employee of Elektrostal

TABLE 1. SUMMARY OF CONFIRMED PROLIFERATION SIGNIFICANT INCIDENTS OF HEU AND PU TRAFFICKING IN THE NEWLY INDEPENDENT STATES (1991–2006)[a] (cont.)

Case name, date of diversion	Material diverted	Origin of material	Recovery of material
Sukhumi, unknown	Approximately 2 kg of 90% HEU	I.N. Vekua Physics and Technology Institute, Sukhumi, Georgia	1997-12: Russian inspection team visited facility, which had been closed by 1992 Abkhazian–Georgian conflict, and found facility abandoned, and material included in 1992 inventory missing. Material has not been recovered
Chelyabinsk Oblast, Russian Federation, unknown	18.5 kg of HEU (enrichment level unspecified)	Unknown; possibly Mayak Production Association, Chelyabinsk-70, or Zlatoust-36	1998-12-17: Russian Federal Security service reports that it thwarted an attempt by workers at a nuclear facility in Chelyabinsk Oblast to steal 18.5 kg of nuclear material. 2000-10: Russian Ministry of Atomic Energy official confirms incident involved HEU
Dunav Most, Bulgaria, unknown	4 g of 72% HEU	Unknown	1999-05-29: Bulgarian customs officers discovered HEU hidden in the trunk of a car crossing from Bulgaria into Romania. Driver said he had obtained material in Moldova
Elektrostal, Russian Federation, unknown	3.7 kg of 21% HEU	Unconfirmed; possibly Elektrostal Machine-Building Plant, Bochvar Institute (VNIINM), or Politekh Enterprise, Russian Federation	2000-05: A resident of Elektrostal was detained during an attempt to sell 3.7 kg of uranium enriched to 21% ^{235}U. Incident was reported by Gosatomnadzor
Tbilisi, Georgia, unknown	0.4 g of Pu powder	Unknown	2000-05: An individual was arrested for illegal possession of a small quantity of mixed powder containing about 0.4 g of plutonium and 0.8 g of low enriched uranium

For footnotes see end of table.

TABLE 1. SUMMARY OF CONFIRMED PROLIFERATION SIGNIFICANT INCIDENTS OF HEU AND PU TRAFFICKING IN THE NEWLY INDEPENDENT STATES (1991–2006)[a] (cont.)

Case name, date of diversion	Material diverted	Origin of material	Recovery of material
Paris, France, n.d.	0.5 g of 72% HEU	Unknown; Russian/newly independent State origin suspected	2001-07-16: French police arrested three men and confiscated approximately 0.5 g of HEU
Sadahlo, Georgia, 2003-06-26	170 g of nearly 90% HEU	Unconfirmed; Novosibirsk plant, Russian Federation	2003-06-26: Georgian border guards arrested a man trying to transport the material across the Georgian–Armenian border
Tbilisi, Georgia, 2006-02-01	79.5 g of nearly 90% HEU	Unknown; Russian origin suspected	2006-02-01: Georgian security services in a sting operation arrested a Russian national in Tbilisi attempting to sell 79.5 g of HEU

[a] The table is an updated version of the table originally published in Ref. [1].

[b] This case is included in the list of confirmed trafficking incidents largely on the basis of reports made to the IAEA by the Russian Federation. Additional corroborating evidence, however, is not available.

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ILLEGAL RADIOLOGICAL SUBSTANCES — RESPONDING TO THE TERRORIST, CRIMINAL AND PUBLIC SAFETY DEMANDS IN SCOTLAND*

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DEVELOPING A COMMUNICATION STRATEGY FOR ILLEGAL ACTS INVOLVING RADIOACTIVE MATERIALS — DRAWING ON EXPERIENCE OBTAINED DURING THE POLONIUM-210 INCIDENT IN HAMBURG IN 2006

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Abstract

The paper presents examples of difficulties experienced by the German authorities during the ^{210}Po incident in Hamburg in December 2006, which can be blamed, to varying degrees, on poor internal or external communication. The cases presented draw on the large amount of newspaper coverage of the event, controversial images, actions undertaken by inexperienced emergency responders and, to a lesser extent, anecdotal evidence from the 'worried well' among the emergency responders. The experience obtained has been examined and evaluated, and it is apparent that the inclusion of a communication strategy as part of the response to an intentional attack using radioactive materials, including the threat thereof, could dramatically improve the effectiveness of the emergency services. As a result, a new communication strategy has been developed and is beginning to be adopted by the German national authorities involved in the defence against nuclear hazards. The essential elements of the new communication strategy are described here, with the aim of producing a customized, homogeneous and appropriate response to future incidents involving radioactive materials.

1. INTRODUCTION

Illicitly trafficked radioactive materials could be used illegally in a variety of ways, for instance, extortion, poisoning and the deliberate dispersal of radioactive material. Previous experience of the unintentional dispersal of radioactive material in the city of Goiânia, Brazil [1] has shown that an unsealed radioactive source, in this case ^{137}Cs, can cause severe human health effects in a limited number of victims (there were four deaths). An intentional dispersal of radioactive materials is still a matter of concern and research attention has focused on 'dirty bombs': homemade explosives incorporating radioactive materials (e.g. Ref. [2] and references therein). The consequences to human health of such a bomb have also been discussed recently elsewhere [3] and are not as wide ranging and devastating as generally perceived by the media, the general population and emergency responders. A discrepancy between perceived and actual risk is often present in regard to incidents involving radioactive materials. This discrepancy should not be disregarded, as the psychological effect of such an incident is an important factor in determining the reaction of the public and of emergency responders [4].

In late 2006, the city of Hamburg in northern Germany was faced with a potential dispersal of radioactive ^{210}Po. The Russian citizen Dimitri Kovtun was investigated by the Hamburg Police and found to have stayed in the city in late October 2006 before flying to London to meet with British citizen Alexander Litvinenko at the beginning of November 2006. Litvinenko died in November 2006 in London. His death was caused by radiation poisoning, more specifically, from ^{210}Po. The Hamburg police considered it possible that Kovtun brought the illicitly trafficked ^{210}Po from Moscow to London via Hamburg. At the time, the presence or scale of the dispersal was unknown, leading the city of Hamburg to call on the German national authorities for assistance. The unit responsible for defence against nuclear hazards at the federal level in Germany is known as the ZUB (Zentrale Unterstützungsgruppe des Bundes für gravierende Fälle der nuklearspezifischen Gefahrenabwehr, which may be translated as the Central Federal Support Group for the Defence against Serious Nuclear Hazards) and is a collaboration between the Federal Office for Radiation Protection (BfS), the Federal Police (BPol) and the Federal Criminal Police Office (BKA) [5]. This unit has unique strengths, as it incorporates the expertise of three separate federal institutions, but also has unique communications challenges due to the differing location and cultural nature of the institutions.

This paper presents and discusses the communication problems experienced by the BfS during the ^{210}Po incident in Hamburg and summarizes the new elements of the communication strategy that will be implemented in future deployments. The aim of the communication strategy is to effect an appropriate response from the emergency services, which will not only improve the implementation of measures to prevent harm to human health, but which will also help to reduce panic in the population and prevent unnecessary financial damage due to public fears.

2. DESCRIPTION OF CHALLENGES

It must be mentioned at the beginning of this account that the deployment of the BfS as part of the ZUB and the deployment of the ZUB itself in Hamburg from 8 to 22 December 2006 were successful and that at no time were any members of the emergency services or the public at risk from the health effects of radiation [6]. The communication challenges that have come to light as a result of the deployment can be split into two general categories, relating to internal and external communication. Internal communication in this context is taken to mean communication between members of and/or organizations belonging to the emergency services, some of which are not part of the ZUB. External communication is taken to mean communication between the emergency services and the general public and the media, be this through media images produced by the way the deployment is carried out or through official spokespersons. These two topics, internal and external communication, will be addressed in Sections 2.1 and 2.2, respectively. Discrepancies between internal and external communication also present challenges. This topic is treated separately in Section 2.3, although coordination of the internal and external communication is a general theme in both Sections 2.1 and 2.2.

2.1. Internal communication challenges

A public example of the consequences of ineffective internal communication was given when the family members of the owner of one of the forensic sites were persuaded to take further medical tests after having already left the site for a hotel. The medical tests were planned as a precautionary measure and would give the family a chance to escape the media for a few days. There was no medical emergency and they had been living normally for several weeks at the site. There was no indication of radiation syndrome, nor were more than trace amounts of ^{210}Po found at the scene. One of the main reasons for recommending precautionary medical tests was to put to rest any doubts the family might have about their health. However, the fire brigade responsible for taking the family to the hospital arrived in full protective suits and with a kind of vehicle that is normally used to transport people under triage conditions (Fig. 1). These measures were inappropriate and resulted in the family experiencing a high degree of unnecessary anxiety. As a further result, the family lost trust in the emergency responders and this made obtaining their continued cooperation in the operation more difficult. In addition, as the photos were in the public domain, the effects had to be dealt with using further external communication efforts, as discussed in Section 2.2.

2.2. External communication challenges

External communication was delivered formally in the form of police press conferences in Hamburg and informally in the form of pictures taken by

FIG. 1. Photographs taken from outside a hotel in Hamburg, demonstrating an inappropriate response by the emergency services.

journalists from the perimeter of the forensic sites. The press conferences were broadcast live on German television in the first week of the deployment and were used not only to confirm that traces of ^{210}Po had been found, but also to reassure the public that there was no risk to human health from the trace amounts found. These press conferences were partly undermined by a large proportion of the press coverage, which included pictures taken by journalists from the perimeter of the forensic sites (e.g. those shown in Fig. 1).

In an example taken from newspaper coverage [7], BfS employees wear white forensic suits and carry radiation contamination detectors. The fact that the white forensic suits are normally used in all police forensic investigations is not at the forefront of the coverage, so the lasting impression on the readership is that there are measures being taken that are not purely precautionary, or that the scale of the operation is greater than the authorities have admitted. This impression, once established, undermines the trust that the public has in the emergency responders and leads to a higher level of scepticism regarding the information presented formally in police press conferences. A provocative headline appeared the day after the events occurred (described in Section 2.1) and the suspicious nature of the coverage is partly due to the unfavourable impression made on the journalists by the images shown in Fig. 1. This example shows how important internal communication is for ensuring effective and homogeneous external communication.

2.3. Discrepancies between internal and external sources of information

A communication challenge faced during the deployment in Hamburg that specifically related to the discrepancy between different internal and external sources of information was the fact that the police force involved in securing the forensic sites in the first hours of the deployment had little or no official information about the situation. The information they did receive was via telephone calls from friends and relations who had access to media sources. This led to information being passed around the police force that was, in some cases, misleading. The result was unnecessarily heightened anxiety in the police force and a reduction in the effectiveness of the deployment.

Another example of the discrepancy between the internal and external communication was the fact that several 'worried well' from the police force and their families demanded health checkups based on their impression of the situation from the media coverage. These police officers had not been to the scenes involved in the deployment, so they were not under radiation protection surveillance. The checkups were provided and resulted in an unnecessary strain on health physics resources.

3. A NEW COMMUNICATION STRATEGY

The result of the experience described in Section 2 has been the development of a new communication strategy for future deployments involving incidents with radioactive materials. The new communication strategy will be presented here as two separate sections. Sections 3.1 and 3.2 will deal with the new elements of the internal and external communication strategies, respectively. The deployment specific radiation protection afforded by the BfS is described separately in Section 3.3. The deployment specific radiation protection was already present during the deployment in Hamburg, but it will be described here in addition to the new elements, as it is an essential and integral part of the general communication strategy.

3.1. Internal communication strategy

Internal communication between the ZUB, the state police forces and the other emergency services has been improved using two different methods. Firstly, pre-emptive internal communication has been improved [8]. This is information that is available before an incident involving radioactive materials occurs. For example, detailed information about the ZUB, its aims and its internal structure is now available on secure police intranet sites for all police officers at both the federal and state level. Secondly, the internal communication during the early stages of a deployment has been improved. For example, the police officers who are not members of the ZUB will receive a short training talk and a printed information sheet specific to their impending deployment under the supervision of BfS and BKA specialists directly before they deploy. The information will be partially drawn from selected pre-prepared teaching materials and partially from the sensitive information available about the situation at the deployment site. This is to ensure that the information given to emergency responders is of a specific nature, referring directly to the radionuclide present and its predicted health effects under the conditions used in the dispersal, along with specific radiation protection recommendations.

A further internal communication modification is the development of preprinted information cards. These information cards are similar to those suggested in the IAEA Manual for First Responders [9], as they contain basic safety guidelines for deployments involving radioactive materials. However, the information cards contain additional information for emergency workers that is specific to the German radiation protection regulations [10]. The information cards have been prepared by the BfS and BKA together for distribution to all emergency responders at the scene and will be made available in a laminated pocket size format.

3.2. External communication strategy

It should be mentioned here that the external communication during an event involving radioactive materials can only be improved separately to the internal communication by providing the public with speedy and accurate official information about the incident via press conferences and possibly via an information hotline. An important part of the strategy will be to pass on as much information about the deployment as possible, including the information given to the state police before the deployment (as mentioned in Section 3.1), if possible. A major part of improving the external communication can be afforded by improving the internal communication, as this will give a more homogeneous response to the incident, which in turn will help to remove many of the doubts the public has about the emergency response. This is also addressed further in Section 3.3.

External communication can also be improved by allowing the information contained within the information cards mentioned in Section 3.1 to be made available to members of the public at the scene. The information cards will help the members of the public at the scene protect themselves from radiation and will help build trust, as they will receive the same information as the emergency responders. No information that is sensitive to the deployment is contained on the cards.

3.3. Deployment specific radiation protection

The BfS will continue to conduct the full radiological evaluation of every ZUB deployment in real time, as this was very successfully completed during the ZUB deployment in Hamburg. Deployment specific radiation protection is achieved in two ways. Firstly, the BfS has units on the ground equipped to deliver relevant field measurements (radiation and/or contamination levels, weather conditions and local geography) to the senior radiation protection adviser. The senior radiation protection adviser is a BfS employee who is familiar with the equipment and personnel available for the measurements and has many years of radiation protection experience. The senior radiation protection adviser can be stationed within the operation control centre at all times to evaluate the results of the field measurements and to advise the operation coordinator on the necessary counter and protective measures. This system places radiation protection at the heart of the ZUB deployment command and ensures that the operation plan does not endanger the emergency workers in this respect. It leads to a level of radiation protection that is appropriate to the threat level and allows the emergency response to work more effectively.

4. CONCLUSION AND EVALUATION

The highly successful deployment in response to the ^{210}Po incident in Hamburg in late 2006 brought new external and internal communication challenges to light. These challenges have been addressed through the development and implementation of a new communication strategy. The strategy combines pre-prepared materials with on-site briefings for emergency responders to tailor the response at the scene, as well as increasing the amount and accessibility of the information provided to the public. The presence of the BfS both at the scene, in the form of measurement teams, and in the operation control centre ensures radiation protection for the ZUB deployment. This strategy should deliver a homogeneous, customized and appropriate response from the emergency workers when deployed to deal with future incidents involving radioactive materials in Germany.

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DISCUSSION

SESSION 5: Response to the Detection of Criminal/Unauthorized Movement of Radioactive Material — I

W. GELLETLY (United Kingdom): B. Chartier, (1) how sensitive is your helicopter borne detection system? (2) Do you have radiation background maps for all of France? (3) Do you plan to improve the sensitivity with $LaBr_3$ crystals? K. Mayer, (4) in how many cases could you not identify the production facility? (5) Can you identify the individual reactor of production if you have a reprocessed plutonium sample? (6) How far are we from incorporating nuclear forensics into the NPT?

B. CHARTIER (France): (1) I do not have the answer but I can find out. (2) We are working to establish background radiation on sites of interest — the main nuclear facilities and cities. (3) Not now, but we are continuously upgrading the software used to test the signal.

K. MAYER (European Commission): (4) In approximately 80% of the cases, we could identify the origin (production facility), which was not necessarily the place of theft or diversion. For the other 20%, we were at least able to tell the intended use and most likely the origin of the material. (5) We can distinguish between the plutonium produced in different reactor types but it is not possible to trace it back to a single reactor site. (6) This question is beyond the scientific level and needs to be addressed at the political level.

R. GUYONNET (France): What kind of qualification/certification in the nuclear forensics process is required for prosecution?

K. MAYER (European Commission): Nuclear forensics essentially focuses on the material and supporting prosecution is a side aspect. The main objective is supporting non-proliferation. The quality can vary from laboratory to laboratory. Most methods we apply are accredited according to ISO 17025. For prosecution, the chain of custody needs to be maintained.

SESSION 5: Response to the Detection of Criminal/Unauthorized Movement of Radioactive Material — II

C. PRICE (United Kingdom): This afternoon’s session has revealed that there are many different facets to response.

A.J. AL KHATIBEH (Qatar): Is there any evidence that the material seized in Georgia was destined for Muslim countries or is it based only on the words of the perpetrators?

E.K. SOKOVA (United States of America): In most cases, end users and destinations were not established. However, the perpetrators named these countries or individuals as buyers in their court proceedings. It appears that — in the smugglers' eyes — the Middle East and Muslim countries are where a demand for the material exists.

W. GELLETLY (United Kingdom): (1) In England and Wales, reassurance of the public is the responsibility of the Health Protection Agency (HPA) together with the police. What are the equivalent arrangements in Scotland? (2) The public did not seem to panic during the Litvinenko affair. Do you have any comment?

I. DICKINSON (United Kingdom): (1) The arrangements for the chemical, biological, radiological and nuclear (CBRN) response are consistent throughout the United Kingdom. While the Government in Scotland has slightly different agencies and structure, Scotland's integration into the whole United Kingdom response is identical. For example, the HPA in England is replicated by Health Protection Scotland (HPS) in Scotland although the HPA responds United Kingdom-wide to a radiological incident. The capability and response is identical as we all work to a common model. (2) The joint public agency response to Litvinenko's death was excellent, though extraordinarily extensive, and it reassured the public. However, had his death been replicated — occurring randomly, in large numbers, unconnected — the police response may well have been different and considerable effort would have been necessary to reassure communities.

C. PRICE (United Kingdom): The HPA responders were very conscious, when they went into London hotels, of not going in dressed in great protective suits as that would have created more alarm than the situation warranted.

S. ELEGBA (Nigeria): Since the responders to the Litvinenko case did not 'dress up' in emergency suits, what was the reaction of their friends and families?

C. PRICE (United Kingdom): I was talking about the response by radiation protection specialists who were very capable of assessing the risk to their health.

R.A.A. RAJA ADNAN (Malaysia): (1) Should emergency drills require first responders not to be dressed in full protective clothing so as not to frighten the public? (2) Would the media have reacted similarly in Hamburg had the ^{210}Po at the family's house been found in very high concentration? (3) Was the religion of the smugglers/perpetrators in Georgia known or was that not important?

E. KROEGER (Germany): (1) The German Federal Office for Radiation Protection conducts drills with our partners in the ZUB (Zentrale Unterstützungsgruppe des Bundes für gravierende Fälle der nuklearspezifischen Gefahrenabwehr, which may be translated as the Central Federal Support Group for the Defence against Serious Nuclear Hazards). The exercises include scenarios and full risk assessment. The risk assessment is used to set the radiation protection measures for the given scenario. If this requires full protective clothing, then it is used. I hope that my presentation did not give the impression that protective clothing should not be used as this is not the case at all. (2) The response of the press is difficult to predict, but it probably would have been similar even if higher levels of polonium had been found.

E.K. SOKOVA (United States of America): (3) I do not have information about the faith of the perpetrators in Georgia. However, in some cases, the perpetrators' names and other details were established. For example, for the HEU seizure of 2003, a Turkish suspect (Sadik) was taken into police custody in Turkey and was questioned about his involvement.

S.J. STANLEY (United Kingdom): Are you engaged with the United Kingdom nuclear industry with regard to decontamination technology?

I. DICKINSON (United Kingdom): In the United Kingdom, decontamination is the responsibility of the health and ambulance authorities strongly supported by the fire service. The methods used comply with a sophisticated and carefully developed United Kingdom standard supported by the most capable scientific advice available. The biggest problem is not decontamination of those actually contaminated, but differentiating between those at risk and the 'worried well' who perceive that they are at risk. Reassurance of a large number of people is required. This is similar to the problem of survey — identification and measurement of contaminated areas is probably within our capability. However, the demand to 'prove the negative' to show that places are safe can be considerable.

R. LANTHIER (Canada): Has any thought been given to introducing 'markers' in the manufacture of nuclear material to identify its origin as is done for explosives?

S. BAUDE (France): There is no indication of an intention to do this.

A.J. AL KHATIBEH (Qatar): Are we responding too early? Should we wait to seize material until the end user is found?

C. PRICE (United Kingdom): If something goes wrong subsequently, the government would have to explain why they did nothing although they knew about the potential threat. They would face grave accusations if the inaction led to a serious event. It depends on what you are handling. Where the consequences are potentially serious, the risk of not disrupting the criminal activity as soon as possible probably far outweighs the benefits of trying to catch the people at the end of the chain.

I. DICKINSON (United Kingdom): This is a risk–benefit decision that must be based on the priority of public safety. Whether to intervene early or late will always depend on a judgement made clearly on the basis of risk versus benefit to public safety.

INTERNATIONAL INITIATIVES AND NATIONAL EFFORTS TO ESTABLISH CAPABILITIES

(Session 6)

Chairperson

Y. NAKAGOME
Japan

Rapporteur

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United States of America

IAEA-CN-154/061

PRELIMINARY RADIATION CONTROL BY THE SERBIAN CUSTOMS ADMINISTRATION

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Abstract

Over the past decade, the world has become increasingly concerned about the danger that unsecured nuclear material which could be used for weapons could fall into the hands of terrorists or countries of concern. Customs administrations play a significant role in revealing and combating illicit transportation of radioactive material. It is a general requirement that these controls, as well as other types of controls, performed by different border agencies, become fast and efficient. Precisely within the realization of the adopted integrated border management strategy, in Serbia it has been decided to withdraw the Environmental Protection Agency from the border that was responsible for radiation control. The preliminary control has been taken over by the customs service. Within the joint action project of the IAEA and the European Union on capacity building for combating illicit trafficking of nuclear and radioactive materials, the IAEA donated various items of equipment to the Serbian Customs Administration, including a portal radiation monitor, a multipurpose handheld radioisotope identifier device — a gamma spectrometer, data communication sets and personal radiation detectors, etc. Several workshops and training sessions were organized to increase the capacities of Serbian customs officers. Furthermore, regional cooperation in the field of radioactive control was initiated.

1. INTRODUCTION

According to the IAEA, between 1993 and 2004, there were 650 confirmed cases of illicit trafficking of nuclear and radiological materials worldwide. A significant number of cases involved materials that could be used for the production of either a nuclear weapon or a device that uses conventional explosives with radioactive material (known as a ‘dirty bomb’). Over the past decade, the world has become increasingly concerned about the danger that unsecured nuclear material which could be used for weapons could fall into the hands of terrorists or countries of concern. In the aftermath of 11 September 2001, there is heightened concern that terrorists may try to smuggle nuclear materials or a nuclear weapon. As a consequence, customs administrations play a significant role in revealing and combating illicit transportation of radioactive material.

However, due to the constant increase not only in trade volume, but also in tourist, cultural and educational exchange at the global level, there is a need for fast and efficient crossing of national borders. Border crossings require the implementation of certain controls with the aim of preventing illegal traffic. It is a general demand that these controls become fast and efficient. Certainly, the question is how to provide good coordination for operating several border agencies (in some countries there are as many as nine agencies), how to prevent the overlapping of authorities and duplication of controls. The main concept of integrated border management (IBM) is to deal with this issue.

In 2006, Serbia adopted the IBM strategy, an action plan for its implementation and departmental strategies. The main objective of IBM is to achieve a balance between open and, at the same time, safe and controlled borders. It should be taken into account that State border control refers to persons, means of transport and goods, and that it involves different border agencies.

The efficient border management principle means an open border for trade and movement of persons, but a closed border for all criminal activities. Within the realization of the adopted strategy, it was decided to withdraw the Environmental Protection Agency from the border that was responsible for radiation control. The preliminary control has been taken over by the customs service.

In July 2006, in line with the IBM strategy, the Ministry of Science and Environmental Protection and the Serbian customs signed an agreement on radiation controls performed by customs officials at the border. It is prescribed by the agreement that customs officers at the border are trained to use a pager detector and to carry out the preliminary radiation control of all goods. Taking over this competency required comprehensive preparation and adequate training. Cooperation with the IAEA played a significant role during this action.

2. COOPERATION WITH THE IAEA

In the framework of a border control project, the IAEA and the European Union offered assistance to the Serbian Customs Administration (SCA) including equipment and vocational training in the area of fighting against the smuggling of nuclear and other radioactive materials for the purpose of improving the capacities of the competent authorities (customs and border police).

Upon the invitation of, at that time, the State of Serbia and Montenegro, an international nuclear security service mission was conducted from 5 to 14 December 2004 to review the security measures in place, visit relevant facilities and interview officials and technical personnel in order to fulfil the objectives of the mission. The objectives were to review the national system for the detection of and response to illicit trafficking, to determine the needs and concerns of the State authorities in this area, to develop a work plan for providing the required assistance and to propose an action plan in the light of the mission's findings. The aim was to screen the actual situation and define needs in the area of radiation control, especially from the aspect of physical security of radiation materials. A comprehensive report and project proposal were written. The joint action project of the IAEA and the European Union on strengthening a State's capabilities for detection and response to illicit trafficking is financed by the European Union (€200 000), while the IAEA provides expert support. The following was planned within the project:

— Donation of portal and other equipment for radiation control at border crossings for customs officials;
— Donation of state of the art instruments for radiation control for local experts of the Vinca Institute aiming to provide assistance and support for customs officials;
— Training the beneficiaries in the use of the donated devices mentioned;
— Training of relevant officers concerning national methodology and guidelines for fighting against the smuggling of nuclear and other radioactive material;
— A workshop for top managers with the aim of increasing awareness about the importance of nuclear security.

The SCA has been involved in activities related to the project since June 2006. IAEA representatives paid a visit to the SCA as early as July 2006. The aim of the visit was, apart from a mutual meeting of all the persons engaged in the project, to establish the technical details necessary for portal set up and allocation of the donated handheld equipment. The team also visited the Gradina border crossing point, where it was planned to install the portal.

Through this cooperation, the necessary legal and regulatory basis for effective export controls is being established and appropriate export authorization (i.e. licensing procedures and practices) is being developed. In addition, effective enforcement capabilities and procedures are being instated, including through enhancing the provision of detection and interdiction equipment. Effective interaction between governments and industry on export controls is also being promoted.

3. TAKING OVER PRELIMINARY RADIATION CONTROL

The Ministry of Finance and the Ministry of Science and Environmental Protection signed an agreement by which the SCA took over preliminary radiation control from the Ministry of Science and Environmental Protection on 17 July 2006. This agreement was in accordance with the IBM strategy.

The SCA issued border radiation control instructions. In addition to precise instructions on procedures in certain circumstances, an integral part of the instructions are:

- A list of goods subject to additional measurements (gamma spectrometry and dosimetry);
- Contact telephone numbers of environmental inspectors;
- A list of border crossings where environmental supervision is performed;
- A list of legal persons who have permission for transporting and/or servicing sources of ionizing radiation;
- A list of legal persons authorized to undertake gamma spectrometric measurements;
- A list of legal persons authorized in dosimetry.

The procedure is as follows: if the pager does not detect a higher level of radiation, a customs officer is not obliged to write a report for radiation examination. If the radiation level is higher, the customs officer informs his superior, who contacts an ecology inspection agent from the Environmental Protection Agency (Ministry of Science and Environmental Protection). The transport vehicle or person associated with the higher than permitted detected radiation is isolated at a safe place at the border and placed under customs supervision. Ecology inspection agents are present at certain border crossing points and can be contacted if necessary.

For goods that are on the list of goods which are subject to additional measurements (gamma spectrometry and dosimetry), the procedure is described in the following discussion. The importer must notify the authorized border post in advance regarding a shipment which is subject to additional measurements to allow sampling by the authorized legal entity selected at his discretion. The customs officer enters a note on the supervised document that a sample has been taken and that the release of goods for free circulation is forbidden until the measurement results have been received. The goods are released to the regional customs terminal for temporary storage pending the sampling results. If positive, the goods are cleared, with the authorization number of the entity which conducted the test being written on the declaration by the customs officer. If negative, the environmental inspector is notified. The customs post is required to keep separate records of stored goods requiring additional gamma spectrometry analysis.

For goods from the list requiring additional measurements, the border point is provided with the decision allowing the free circulation of the source of ionizing radiation as well as the registration that allows the legal entity to freely circulate the goods. Otherwise, import, export, transit or forwarding to the customs office of the destination is not allowed.

Furthermore, efforts are made to secure national borders through the installation of radiation detection equipment and to ensure that frontline officers have adequate training and support to deal with and respond to seizures and detection alarms.

The instructions under which customs officers operate refer primarily to consumer protection, i.e. that imported goods do not have a higher radiation level than similar goods produced in Serbia. As far as nuclear and radiation safety is concerned, customs officers are instructed that such goods arriving at the border without the required permits are not allowed to enter the country and are sent back. The reason such shipments are not confiscated, as recommended by the IAEA, is due to lack of adequate storage facilities in Serbia.

4. CAPACITY BUILDING OF CUSTOMS OFFICERS

Human capital issues are one of primary concern. Nuclear technologies continue to benefit us in many ways and, therefore, will continue to be a critical focal point of many national security, foreign, energy and environmental policies for the foreseeable future. With this assumption, it follows that a nation needs a highly educated and well trained work force. Although some progress in this vital area has been made, far more work is needed. Training of staff is a key component of an effective and efficient radiation control programme. Regarding controls, the IAEA has organized several training sessions and seminars attended by Serbian customs officials — in Serbia, Greece, Germany, Cyprus and Croatia — and hopefully will continue with this successful collaboration.

4.1. Regional training course on advanced detection equipment: Athens, Greece, September 2006

The purpose of the course, funded by the European Union, was to provide frontline officer participants with a demonstration of instruments currently available to monitor, detect and identify nuclear and other radioactive material, and to improve a State's capacities for detection of and response to incidents, as well as to enhance coordination between first responders and the second line of response through equipment training run in parallel. Twelve customs officers from Belgrade airport, and the Serbian border crossing points Gradina (to Bulgaria) and Vatin (to Romania) attended the course in two sessions.

4.2. Workshop on the response to illicit trafficking incidents involving nuclear and other radioactive material: Karlsruhe, Germany, November 2006

This seminar was complementary to the workshop in Athens, Greece and was intended for senior officers. There was a series of lectures, hands on demonstration and practical exercises. The goal of the seminar was, apart from raising the level of awareness and education regarding radioactivity, to discover the weak points of the current detection equipment measuring radioactivity levels and to provide information on the existence of the IAEA database for confiscated radioactive sources and the illicit trafficking of nuclear and other radioactive materials.

4.3. Serbia national awareness seminar on combating illicit trafficking in nuclear and radioactive materials: Belgrade, Serbia, December 2006

The purpose of this seminar was to increase the awareness of managers, decision makers and senior staff from customs and law enforcement authorities on nuclear security needs related to illicit trafficking in nuclear and other radioactive materials. In addition, it provided basic knowledge and understanding of response procedures and equipment needed to combat illicit trafficking, as well as the relevant international and regional legal instruments and basic steps for the response to incidents. There were 28 people in attendance.

4.4. Seminar on the dangers resulting from illicit trade in nuclear and radioactive materials: Zagreb, Croatia, January 2007

Two senior officers attended this seminar.

4.5. Introduction to radiation detection equipment: Zagreb, Croatia, January 2007

Two line customs officers attended.

4.6. Regional training course on radiation safety for customs officers: Nicosia, Cyprus, October 2007

5. DETECTION EQUIPMENT

The following is a list of detection equipment donated to the SCA by the IAEA:

— Nine handheld gamma spectrometers (IdentiFINDER Ultra);
— Thirty-three radiation detection pagers (Polymaster PRD);
— Three infrared devices;
— Five communication equipment sets (infrared devices and cables);
— Five PRD RadEye — radiation detection device THERMO FH41P;
— One portal monitor for measuring radioactivity.

The total value of the donated equipment was US $124 441 and €56 900 (portal value). The US Government previously donated 94 pagers.

5.1. Training in the use of detection equipment

The SCA organized a three day training programme for 500 customs officers in cooperation with the Institute of Physics in Belgrade, Serbia. The training costs (US $50 000) were covered by a World Bank loan received for the Trade and Transport Facilitations in South East Europe (TTFSE) project. All the participants received two brochures containing information on radioactivity, written in a popular way, so that all the customs officers could easily understand the unfamiliar subject matter.

The training was very successful and the initial doubts and apprehensions turned into understanding and cooperation.

6. INTERNATIONAL COOPERATION

Apart from cooperation with the IAEA, the SCA cooperates with the US Government through the Export Control and Border Security Assistance (EXBS) programme that has a broad set of mission goals. It is concerned with halting illicit trafficking of all weapons of mass destruction (WMD), as well as dual-use goods and related technologies useful for WMD production.

6.1. Regional meeting on radioactive protection and supervision of radioactive scrap metal: Zagreb, Croatia, March 2007

Representatives of the appropriate ministries of Bosnia and Herzegovina, the Former Yugoslav Republic of Macedonia, Serbia, Montenegro and Croatia attended the meeting. The goal was to reach an agreement on the methods of transport supervision, procedures in the case of detecting radioactivity at border crossings, the way of notifying all interested States, the obligations of the State from which the source originated as well as the possible routes of radioactive material ending up as scrap metal.

Important conclusions were adopted:

- In the case of an incident, the information is sent to all countries in the region, first of all to the country from which the shipment arrived;
- The control of radioactivity is to be treated as a regional problem, hence the installation of fixed portals is being organized at a regional level, by consulting data on the movement of scrap metal and all other radioactive material.

7. FUTURE ACTIVITIES

Training for an additional 200 customs officers in the use of pagers and gamma spectrometers has been planned. SCA budget funds for this training for 2008 have been planned. The SCA has applied for financing from the IPA 2008, for the purchase of eight stationary detection portals, which would be installed at the most frequent border crossings along pan-European corridor 10. The Gradina portal acceptance test to be carried out by IAEA experts is planned for the beginning of November. Preparations are in place for organizing the second regional meeting on radioactive protection and supervision of radioactive scrap metal in Belgrade, Serbia, at the end of 2007.

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IMPROVING CONTROL OF HIGH RISK CUSTOMS MERCHANDISE IN PARAGUAY

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Abstract

Paraguay shares its borders with Argentina, Brazil and Bolivia. Import and/or export loads must be subjected to several types of controls before arriving at their destination; this includes controlling for radioactive substances and anticipating illicit trafficking of radioactive material. In order to improve control at border points, the National Direction of Customs of Paraguay decided to install detectors in the primary zones of ports, airports and railway terminals, and of areas of automotive transport, as well as at other locations where loading and unloading of goods takes place. Adequate control of exported and imported merchandise diminished for several reasons: false declaration of the weight of products, irresponsible personnel, robberies, political influences, camouflaged or hidden drugs, lack of detectors and qualification of civil employees. These are some of the reasons why merchandise from Paraguay is given low credibility and is not accepted in foreign ports. For this reason, the National Direction of Customs of Paraguay decided to change the image of the country and adapted to the international exigencies of worldwide commerce. The normative framework to ensure and to facilitate global commerce, with the support of the World Customs Organization (WCO), was signed in Brussels on 25 June 2005. Thus, Paraguay fulfils Law 2422/04, implementing systems of control that avoid trafficking in drugs, robbery of radioactive material, dangerous arms and substances, which appear to be camouflaged between imported and exported merchandise.

1. INTRODUCTION

In the past, the Customs of Paraguay had serious problems with the export and import of products due to lack of controls which caused economic, social and other problems, and jeopardized the image of the country. Adequate control of exported and imported merchandise diminished for several reasons: false declaration of weights of products, irresponsible civil employees, robberies, political influences and camouflaged or hidden drugs. These are some of the reasons why Paraguay is considered to be a country of low credibility and this influences the manner in which exported merchandise is treated in foreign ports, namely being held up in customs, or being retained because drugs, radioactive material or arms are hidden among the merchandise.

It was in this context that the National Direction of Customs of Paraguay decided to improve the transparency of its operations, and adapted to the international exigencies of worldwide trade. On 23 June 2005, 166 members of the World Customs Organization (WCO) met in Brussels and unanimously adopted a normative framework to ensure and to facilitate global trade.

In 'The Pillar Customs — Customs' (para. 5), it is stated that in order for it to be effective and to guarantee that the process does not prevent the fluid circulation of merchandise, in the inspection of shipments of high risk, the Administration of Customs will have to use modern technologies that include, among other things, powerful X ray and gamma ray machines and devices to detect radiation. The use of modern technologies to preserve the integrity of the loads and the containers constitutes another fundamental point of this pillar. For this reason, the National Direction of Customs acquired a moveable scanner with X ray and gamma ray technology, and properly applies Law 2422/04 (para. 5) on customs power.

2. OBJECTIVES

- To implement systems of control that avoid trafficking in drugs, arms, radioactive material and dangerous substances;
- To increase the legality of the customs operations in order to diminish the discretion of civil employees at the time of verification of merchandise;
- To improve the facilitation of international trade with time reductions through the implementation of modern technologies;
- To undertake effective control at borders to diminish the illicit trafficking of radioactive material.

3. ACTIVITIES

- Purchase of high technology movable scanners that will be located in strategic locations throughout national territory;
- Training of personnel;
- Control of radioactive material with the SOFIA system;
- Use of detectors adopted at customs and borders;
- Participation in programmes of illicit trafficking of radioactive material of the involved institutions: National Commission of Atomic Energy, Ministry of Public Health and Social Welfare, Vice Presidency of the Republic, National Direction of Customs;
- Improvement of the computer science system and support to all the customs officers in the country.

4. DIFFICULTIES

- Advising the authorities on the advantages of suitable controls;
- The customers of the country need to become qualified in the subject;
- Low salary of the controlling employees.

5. GOALS

- Acquisition of moveable equipment HCV, high energy X ray equipment for the control of merchandise;
- Ability to count on modern technologies that include control mechanisms for dangerous and radioactive materials.

6. CONCLUSION

Paraguay is making concerted efforts to fight corruption and illicit trafficking, and to control high risk merchandise in order to join the league of credible countries and to be transparent to the world.

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EXPERIENCE AND PREVENTION OF ILLICIT NUCLEAR TRAFFICKING IN THE DEMOCRATIC REPUBLIC OF THE CONGO

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Abstract

Illicit trafficking of radioactive minerals, precious metals, and strategic and nuclear materials is a generally expanded practice in some parts of the Democratic Republic of the Congo. The phenomenon took place early in the 1990s and amplified from 1998. The main causes of this practice are the political instability that led to general poverty among the population and the lack of a legal framework governing the exploitation of minerals. The aim of the paper is to present the current status of the illicit trafficking of radioactive materials, including minerals and spent sealed and orphan sources. It also deals with the possible consequences of this practice on the environment and on human health. The paper focuses on new policies to mitigate and prevent such illegal activities in the future.

1. INTRODUCTION

The radioactive and nuclear history of the Democratic Republic of the Congo started during the period of colonization of this country. In the 1940s, uranium minerals were exploited extensively to cover the needs for scientific research that resulted in the production of the first atomic bombs [1]. Around the 1960s, uranium exploitation ceased and the mines were closed due to decreasing amounts of high grade minerals [2].

Radiation sources and radioactive materials have been of concern to human beings and the environment long before the terrorist attacks of September 2001. The results of the terrorist events only emphasized the requirement for enhanced control and security of nuclear and radiological materials and facilities in the nuclear community. From different national experiences, it became evident that there was a significant orphan source issue arising from the poor safety and security of radioactive materials around the world. Abandoned radioactive sources and materials, and disused sources are a real subject of concern in most countries where economic and social development is based on civil nuclear applications. The international response to this new threat was the publication by the IAEA, in 1996, of the Basic Safety Standards (BSS) as a joint effort towards the harmonization of radiation and safety standards [3]. Several international conferences were conducted under the auspices of the IAEA in this area to assist Member States to strengthen safety and security of radioactive material by establishing and upgrading regulatory infrastructures.

Ten years after the adoption of the BSS, the international community is facing a new kind of nuclear threat. The possibility of using radioactive sources or materials as weapons of terror presents a new and real challenge for regulatory authorities in nuclear nations.

Security and safety against the diversion of radioactive and nuclear materials from their peaceful use, and sabotage and theft of these harmful materials, may not present concerns of the same magnitude to developed countries. However, for developing nations such as the Congo, security and physical protection of nuclear facilities is still a big regulatory challenge even if the security issue is under control since the commissioning of the first research reactor Triga MK I in 1959.

The purpose of this paper is to present the general situation on illicit trafficking of radioactive materials, including minerals, spent sealed radioactive sources and orphan sources, the consequences of such trafficking on the environment and on human health, and the security measures to be set up to prohibit and prevent such activities in the future.

Unlike other mineral material trafficked earlier, such as diamonds and gold, uranium mineral trafficking started with the degradation of the most important mining company of the country (Gécamines), due to an unfavourable political environment that led to the exodus of qualified workers.

2. DESCRIPTION OF ILLICIT TRAFFICKED RADIOACTIVE MATERIALS

The illicit trafficking of radioactive materials is concerned with two categories of radioactive substances: radioactive minerals, and radioactive materials and devices.

2.1. Trafficked minerals

The illicit trafficking of minerals is concerned with their fraudulent and anarchical exploitation, especially in the zone of the Congolese copper belt in the southern province of Katanga covering about 18 000 km^2. Apart from Cu, other metals such Co, Cd, Au, Mn, Pb, Ag, Zn and Ni are also exploited. Uranium minerals also exist in this area, with the main uranium indications located in Shinkolobwe territory where this metal was extracted between 1945 and 1959 [4].

Monitoring and analytical measurements achieved on several geological material samples from the Gécamines underground mines [5, 6] at Kipushi provided evidence of the presence of uranium as a by-product essentially in the mineral filling materials rather than in the main minerals. Table 1 presents the Th and U contents in a variety of copper belt minerals and filling materials.

The unfavourable political environment that existed in the Congo in the 1990s had a negative impact on the economic and social situation of local workers and strongly affected their lifestyle. It led some mine workers to emigrate to neighbouring countries, particularly South Africa. In addition, because of the loss of their jobs, a significant fraction of these new jobless

TABLE 1. TH AND U CONTENTS IN SOME SAMPLES FROM THE COPPER BELT [7]

Sample codes	Concentrations		Ratio $\frac{Mineral\ U}{Earth\ Crust\ U}$
	Th (ppm)	U (ppm)	
Lower ore–body oxide	15.34	1.09	0.27
Lower composite ore–body	0.84	0.51	0.13
Lower ore–body sulphite	1.08	27.40	6.85
Upper ore–body oxide	5.22	5.76	1.44
Upper composite ore–body	6.80	50.55	12.64
Upper ore–body sulphite	12.91	33.31	8.33
Malachite, a Cu oxide mineral	5.37	0.18	0.05
Blend–pyrite, a Zn mineral	3.08	14.4	3.60
Chalcopyrite, a 2% Cu mineral	13.05	5.04	1.26
Chalcopyrite–blend, a Cu–Zn mineral	0.94	0.62	0.16
Earth crust [8]	10	4	

individuals started exploiting abandoned mines searching for Cu, Co and Au residues for survival. Consequently, the first cases of illicit exploitation of uranium minerals associated with these practices were reported very soon after the rock slides that occurred in 2004.

This uncontrolled mineral exploitation became worse when several mining companies were licensed by Gécamines to exploit, purchase minerals from individuals, and export raw materials and concentrates.

2.2. Trafficked radioactive devices and materials

Two subcategories of these radioactive materials are currently encountered on the black market in the Congo: true and false radioactive materials. The true radioactive materials are often industrial abandoned sources discarded with technology changes and contain some radioactivity. False radioactive materials, however, are often made of artefact materials without economic value and are subtly simulated just to cheat potential interested customers out of money. They are carefully lead shielded to be convincing. Their radioactivity is noticeably close to background. Holders of such materials dream and believe in the high economic value of their risky business. Some of these materials and devices are shown in Fig. 1. Readings on both of them ascertain that they contain ^{238}U and in some cases ^{235}U or ^{137}Cs, and are manufactured in Ohio, USA. Inspection and measurements carried out on some of them by international expert missions from the IAEA and from the USA were inconclusive regarding their origin.

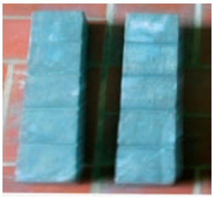
Some cases of this trafficking are still being reported but the increasing public interest caused by the prospect of a big profit in selling ‘uranium material’ has decreased substantially, since there is an increasing awareness of the danger and inopportunity of such a business.

3. NATIONAL RESPONSE TO MALEVOLENT ACTS INVOLVING ILLICIT TRAFFICKING OF RADIOACTIVE MATERIALS

Soon after the cases of illicit exploitation of uranium minerals were reported to local authorities, inspection missions were carried out to the mining site of Shinkolobwe. In 2004, the inspection mission conducted by the Minister of Scientific Research consisted of IAEA and CGEA experts that investigated the suspected site for a radioactivity assessment. The IAEA inspectors noticed a high rate of radioactivity on the site but could not confirm the presence of uranium minerals among the exported minerals. Nevertheless, recommendations were formulated to the Government of the Congo to close this mining site

Glazed metallic box with Leopold II photograph with the following inscription: “Léopold II, Roi des Belges, Souverain de l’Etat Indépendant du Congo”. A red platelet with the inscription: “Congo Belge, 1952, PRT 12 kg, PN 2 kg, TN 70%, URANIUM”. Radioactivity level: ^{238}U traces detected.

Robot with the inscription: “Caution! Radioactive material, Model Cu/12-520-6-1745, Serial number 388420-MB-111, energy: 0.2 MeV, radioactivity: 150 000 c/s, date: 1968, Ohio-USA”. Radioactivity level: ^{238}U detected at the bottom level.



Lead rods segmented with the inscription: “MTK, ^{238}U, ^{235}U, London Standard 1990, HYOTT”. Radioactivity level: background.

A steel covered brick of lead without inscription. Radioactivity level: background.

A robot with the inscription: “Caution! Radioactive material, Model Cu/12-520-6-1745, Serial number 388420-MB-111, energy: 0.2 MeV, radioactivity: 150 000 c/s, date: 1968, Ohio-USA”. Radioactivity level: background radioactivity level: background.

Colonial helmet with the inscription: “Caution! Radioactive material, Model MAI-8-2103-50-15650-1, Serial number 388422/CE 18BC, SR: U-238, The OL ART Cincinnati, Ohio-USA, date: 30/10/1968”. Radioactivity level: background.

FIG. 1. Typical trafficked radioactive materials and devices tested at CRENK.

to the public and to prohibit the traditional exploitation of cobalt and other minerals. Another expert mission was conducted by CGEA radioprotection experts to assess the impact of the radioactivity dissemination in some mining sites in order to formulate mitigation actions.

As a consequence:

- The Government reacted by publishing presidential Decree No. 04/017 of 11 July 2004, prohibiting the access of the population and any mining activities on the Shinkolobwe site. Specific enforcement measures were then issued by an interministerial decree;
- To enforce radioactivity control of exported minerals at borders, especially at the post of Kasumbalesa, a local training course on radiation protection was organized for operating staff members of the Congolese Office for Control (OCC) and the National Intelligence Service;
- Recently, another measure dealing with the implementation of a CGEA representation in this province has been decided; to strictly control radioactivity not only at borders but at any exploiting and storage sites, and to also control environmental activities and for other scientific purposes.

4. IMPACT ASSESSMENT OF ILLICIT TRAFFICKING OF RADIOACTIVE MINERALS

In order to assess the contamination of the mining zone of Shinkolobwe, different sampling and radioactive measurements have been carried out in the course of the last five years. Table 2 illustrates the different results of the sampling and monitoring of the site.

Sampling involved soil, and water was conditioned and analysed using the gamma spectroscopy technique. The results, calculated in Bq/kg, were converted to EE in ppm, except for water samples where they are expressed in μg/kg (ppb). The results of the samples and measurements undertaken are presented in Table 3.

5. NATIONAL PROVISION FOR REGULATING AND CONTROLLING RADIOACTIVE AND NUCLEAR ACTIVITIES [10]

5.1. Legislation and regulation provisions

National regulatory infrastructure for radiation protection and safety consists of three levels:

TABLE 2. RESULTS OF RADIOACTIVITY MEASUREMENTS ON THE SITE OF SHINKOLOBWE [9]

Location	Maximum dose rate (μSv/h)
SH.01	7.5
SH.02	1.1
SH.03	2.5
SH.04	71
SH.05	84–140
SH.06	36
SH.07	3–84
Rock samples	1.11
	0.96
	6.10
Miner waiting room	32

TABLE 3. URANIUM CONTENT IN SOME ENVIRONMENTAL SAMPLES

Nature	U content (ppm)		
Soil 1	48.27	±	9.39
Soil 2	49.41	±	14.99
Soil 3	5604.85	±	1061.69
Soil 4	4277.91	±	730.30
Soil 5	5475.06	±	1101.03
Soil 6	210.00	±	30.53
Soil 7	183.03	±	52.83
Soil 8	39.24	±	10.66
Water	0.26	±	0.09

— General legislation: Act No. 017-2002 of 17 October 2002: It deals with protection against the dangers of ionizing radiation, and the physical protection of nuclear materials and facilities;
— General Regulation: Decree No. 05/022: Regulates the protection against dangers of ionizing radiation;

— Specific regulations (interministerial decrees being processed): Regarding radioactive waste management and food irradiation.

5.2. Institutional provision

With regard to the law, the institutional structure includes three establishments with specific authorities:

(a) Regulatory authority: National Council for Protection against Ionizing Radiations (CNPRI). Its mission consists of:
- Permanent control of inadvertent movement or illicit trafficking of radioactive materials and devices is ensured by the CNPRI through law 017/2002;
- Possession, import, export, storage and transfer of radiation sources and radioactive materials are subject to regulatory authorizations;
- CNPRI inspectors are empowered to inspect any premises and installations where radioactive materials, sources and equipment are suspected.

The CNPRI management staff has been appointed with the mission of organizing regulatory structures.

(b) Supporting establishments: National Institute of Radiation Protection (INRP). Its mission consists of:
- Developing and performing research programmes in the radiation protection and radiological safety fields;
- Promoting measures and methods devoted to protection against ionizing radiation dangers at the national level;
- Ensuring training and expertise in the radiation protection field;
- Maintaining standards and dose measurement instruments, and participating at intercomparison runs in radiation protection.

(c) National Council for Nuclear Security (CNSN): It was created by presidential Decree No. 05/020 to act as a public service coordinating the means for combating illicit trafficking of nuclear and radioactive materials. Supervised by the Minister of Scientific and Technological Research. Its mission consists of:
- Fighting against illicit trafficking of nuclear and radioactive materials by preventing and detecting theft acts, illegal transfer, sabotage of nuclear installations and non-authorized access to nuclear facilities;

— Collecting and conveying radioactive and nuclear materials to CNPRI;
— Preventing malevolent acts involving radioactive and nuclear materials.

6. CONCLUSIONS

There is evidence that illicit trafficking of nuclear material occurs in the Congo through exported mineral and sealed radioactive materials. If the last category may be easily overcome, the former poses a problem of strategies in the present legal and statutory context of mineral exploitation and export.

As mentioned above, considerable efforts have been invested in the course of the last decade to make Congolese policy conform to international requirements in the utilization of nuclear and radioactive materials and sources, and the prevention against their abusive utilization. The legal and regulatory measures will have a great impact not only on combating illicit and risky trafficking of radioactive matters, but also in view of protecting the national economy from uncontrolled and fraudulent exploitation and exportation of uranium minerals, and on preserving the environment and public health as well.

The development, implementation and enforcement of these new structures along with the existing ones will result in creating a real synergy with a view to strengthening the struggle and preventing illicit trafficking of radioactive materials and minerals by progressive and permanent regulatory actions. The need for an effective regulatory infrastructure is such a real challenge for our country that international cooperation is sought to fulfil the requirements for national and international security against threats of malevolent acts involving radioactive materials and minerals.

The Congo has gained a certain amount of experience in this field due to its long utilization of radioactive materials and minerals. However, implementation of very sophisticated regulatory mechanisms to deal with nuclear security requires international support.

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BORDER CONTROL OF NUCLEAR AND OTHER RADIOACTIVE MATERIALS

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Abstract

In the second half of 2006, stationary detection systems for nuclear and other radioactive materials were installed at the border crossing of Bregana, Croatia. Yantar 2U, which is the commercial name of the system, is an integrated automatic system capable of detection of nuclear and other radioactive materials prepared for fixed site customs applications (of Russian origin). The installed system contains portal monitors, a camera, communication lines, communication boxes and a server. Two fully functional separate systems have been installed at the Bregana border crossing, one at the truck entrance and another one at the car entrance. In the paper, the operational experience of the installed system is presented. This includes a statistical analysis of the recorded alarms, an evaluation of the procedures for operational staff, and maintenance and typical malfunction experiences, as well as some recommendations for future use of the detection systems.

1. INTRODUCTION

According to international agreements, the movement of all nuclear and other radioactive materials within and between States should be subject to high standards of regulatory, administrative, safety and engineering controls to ensure that such movements are conducted in a safe and secure manner. In the case of nuclear material, there are additional requirements for physical protection and accountability to ensure against threats of nuclear proliferation and to safeguard against any attempts at diversion.

The results of the terrorist attack of September 2001 emphasized the requirement for enhanced control and security of nuclear and other radioactive materials. In this regard, measures are being taken to increase the global levels of physical protection and security for nuclear materials. In a similar manner, efforts are under way to enhance the safety and security of radioactive sources so prevalent in many industries and healthcare facilities. It follows that the detection of radioactive materials (nuclear material and radioactive sources) at borders is an essential component of an overall strategy to ensure that such materials do not fall into the hands of terrorist groups and criminal organizations that would supply them. Shipments of radioactive materials warrant the attention of law enforcement and regulatory agencies to ascertain their legality, and to prevent diversion and illicit trafficking.

Experiences in many parts of the world continue to prove that movements of nuclear and other radioactive materials outside of the regulatory and legal frameworks continue to occur. Such movements may be either deliberate or inadvertent. A deliberate, illegal movement of nuclear and other radioactive materials for terrorist, political or illegal profit is generally understood to be illicit trafficking. The more common movements outside of regulatory control are inadvertent in nature. An example of an inadvertent movement might be the transport of steel contaminated by a melted radioactive source that was lost from proper controls. Such a shipment may present health and safety threats to the personnel involved as well as to the general public.

States are responsible for combating illicit trafficking and inadvertent movements of nuclear and other radioactive materials.

Regulatory and other law enforcement bodies are advised to cooperate and regularly exchange information as part of strengthening their capabilities for increasing security and preventing a loss of control over nuclear and other radioactive materials. It is recommended that this be done domestically and internationally, and that advantage is taken of the current cooperative initiatives of the IAEA, the World Customs Organization (WCO), the International Criminal Police Organization (INTERPOL) and the European Commission.

On the national level, it is recommended that a national programme on the prevention of inadvertent movement and illicit trafficking include all competent national agencies with related responsibilities.

2. PURPOSE OF INSTALLING THE YANTAR SYSTEM

The Yantar system is intended for installation at customs inspection points where pedestrians or vehicles are inspected for unauthorized transfer of fissile or radioactive materials. The standard option for use of the systems is listed in Table 1.

The system may also be used at other industrial, commercial or military facilities (nuclear power plant involved in the extraction or processing of nuclear materials, military nuclear installations and storage facilities).

Operating conditions are listed in Table 2.

TABLE 1. STANDARD OPTIONS FOR USE OF THE SYSTEMS

Yantar-1U	To inspect cars, vans
	To inspect pedestrians
Yantar-1U1	To inspect cars only in one lane of the road in case of two lane traffic
Yantar-2U	To inspect large vehicles (trucks, trailers, 20TUE and 40TUE containers)
	To inspect pedestrians

2.1. Specifications

The system detects radioactive materials transported in the inspection area. The dimensions of the area are given in Table 3.

TABLE 2. OPERATING CONDITIONS OF THE YANTAR SYSTEM

	Rack UVK-09	Control panel PVC-01
Operating temperature	–25–50°C	0–40°C
Relative humidity	up to 100% at 40°C	
Providing protection	up to IP54	
Conforms to standards	EN60950, EN50081-2, EN50082-2	
	ASTM standards C993-92 category II	
Approvals		

TABLE 3. DIMENSIONS OF THE AREA

Description	Purpose	Inspection area dimensions (m)		Speed in area (km/h)
		Width	Height	
Yantar-2U	Pedestrian	3 (0.8 –3)	2	1–5
	Vehicle	6 (4–8)	3	5–10
Yantar-1U, 1U1	Pedestrian	1.5 (0.8 –1.5)	2	1–5
	Vehicle	3 (3–4)	3	5–10

The minimum detectable masses of nuclear material and gamma ray source activities (for a detection probability of 0.5 at the 95% confidence level) have the maximum values indicated in Table 4.

2.2. The system is sensitive to the following particle energies

Gamma ray channel: 0.05–5 MeV;
Neutrons channel: 0.06–10 MeV.

The detector unit for the gamma ray channel has a minimum sensitivity of 40 (counts/s)/kBq (for ^{137}Cs gamma rays). The detector unit for the neutron channel has a minimum sensitivity of 0.01 counts/n (for ^{252}Cf neutrons). The system has a maximum nuisance alarm rate of 1/1000.

3. METHODS

The Yantar systems were installed at the Bregana border crossing 24 km away from Zagreb as a pilot system. Before the Yantar systems were installed,

TABLE 4. MINIMUM DETECTABLE MASSES OF NUCLEAR MATERIAL AND GAMMA RAY SOURCE ACTIVITIES

Description	Purpose	Maximum mass of material (g)		
		^{239}Pu	^{235}U	^{239}Pu (4 cm lead shield)
Yantar-2U	Pedestrian	0.3	10	50
	Vehicle	10	1000	100
Yantar-1U, Yantar-1U1	Pedestrian	0.3	10	50
	Vehicle	10	1000	100
Description	**Purpose**	**Activity of gamma ray source (kBq)**		
		^{133}Ba	^{137}Cs	^{60}Co
Yantar-2U	Pedestrian	56	70	35
	Vehicle	770	940	480
Yantar-1U, Yantar-1U1	Pedestrian	56	70	35
	Vehicle	770	940	480

Croatia did not have any control of that type at border crossings, although now, according to the Phare projects, there will be another 14 installed. That is one of the reasons why this experience will be useful in the near future. Croatian police and customs officers did not have any experience working with these systems, so after the installation (9 November 2006), there was one quick training course. This should be improved in the future.

The statistics on the alarms triggered at the truck and pedestrian passes will be presented for the period of the installation of the system until 11 March 2007.

The distribution of alarms according to commodity type is presented in Fig. 1.

The total number of alarms recorded by the radiological portal monitors is presented in Fig. 2 and Table 5.

It is clear that most alarms were triggered by ceramics (65.24%), granite (11.20%) and fertilizers (6.65%) at the truck pass and by medical treatments (5.30%) at the car pass. An analysis of their counts per days (counts/background) is shown in Figs 3 and 4 for gamma alarms, and in Figs 5 and 6 for neutron counts (counts/background).

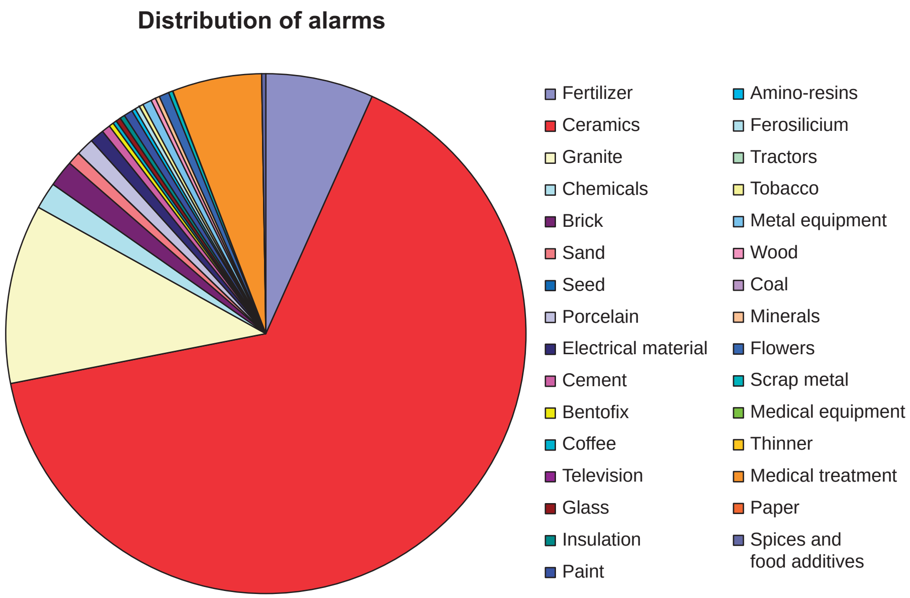

FIG. 1. Distribution of alarms according to commodity type.

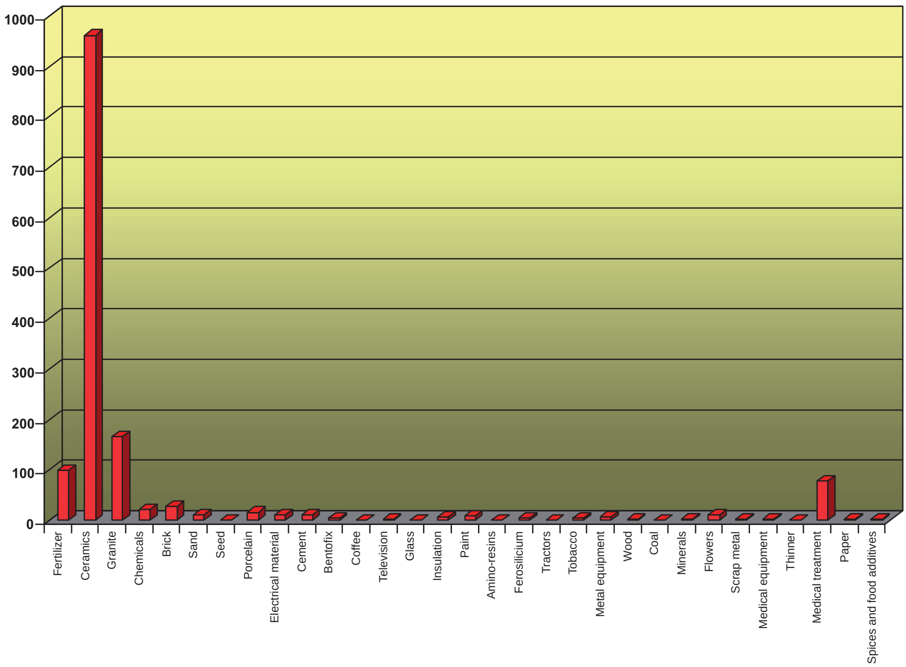

FIG. 2. Total number of alarms.

4. STATE OFFICE FOR NUCLEAR SAFETY

The State Office for Nuclear Safety (SONS) was established based on the Nuclear Safety Act (Official Gazette No. 173/2003) as an independent State organization responsible for all questions in connection with the safe use of nuclear energy and technology, for expert matters of preparedness in the case of a nuclear emergency, as well as for international cooperation in these fields (regulatory body). SONS is currently organized into two divisions and two independent departments with 18 working places. The work of SONS is managed by the director, who is appointed by the Government of Croatia. The organization of SONS started on 1 June 2005, and at the moment there are 12 employees. In its work, SONS can use external help of expert organizations if needed, especially for the maintenance of equipment and independent analyses. SONS is financed completely from the State budget. Additionally, beside its regular activities, SONS is leading national development projects of improvement of the control of nuclear material, preparedness in the case of a nuclear emergency in neighbouring countries and as a basis for international cooperation.

TABLE 5. TOTAL NUMBER OF ALARMS RECORDED BY RADIOLOGICAL PORTAL MONITORS

No.	Type of material	Total no. of alarms	%
1	Fertilizer	98	6.65
2	Ceramics	961	65.24
3	Granite	165	11.20
4	Chemicals	22	1.49
5	Brick	28	1.90
6	Sand	11	0.75
7	Seeds	1	0.07
8	Porcelain	16	1.09
9	Electrical material	11	0.75
10	Cement	10	0.68
11	Bentofix	4	0.27
12	Coffee	1	0.07
13	Television set	3	0.20
14	Glass	1	0.07
15	Insulation	7	0.48
16	Paint	9	0.61
17	Amino-resins	1	0.07
18	Ferosilicium	5	0.34
19	Tractors	1	0.07
20	Tobacco	5	0.34
21	Metal equipment	7	0.48
22	Wood	3	0.20
23	Coal	1	0.07
24	Minerals	2	0.14
25	Flowers	10	0.68
26	Scrap metal	3	0.20
27	Medical equipment	2	0.14
28	Thinner	1	0.07
29	Medical treatment	78	5.30
30	Paper	3	0.20
31	Spices and food additives	3	0.20
	Total	1473	

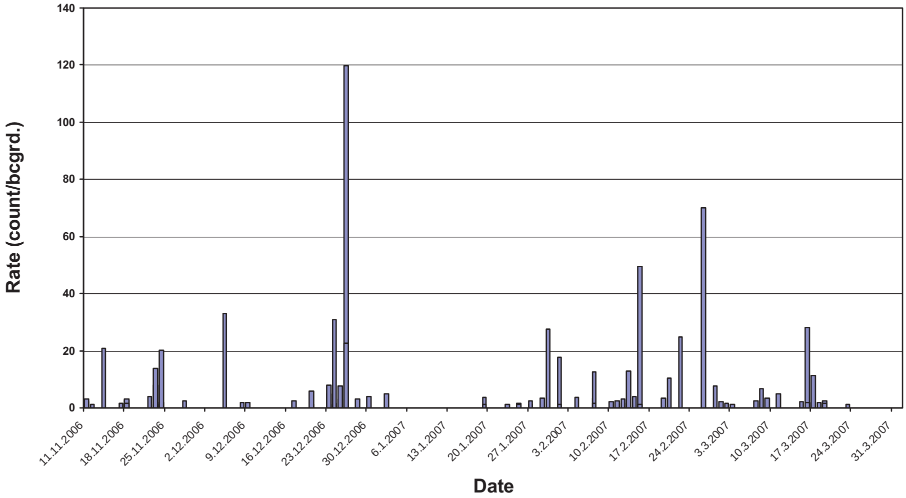

FIG. 3. Gamma alarm counts (counts/background).

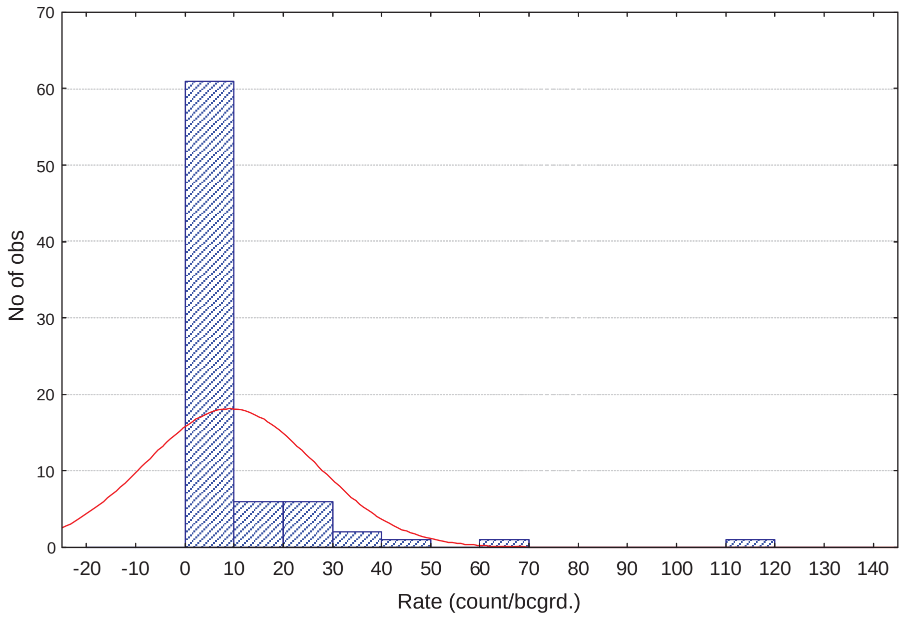

FIG. 4. Gamma alarms.

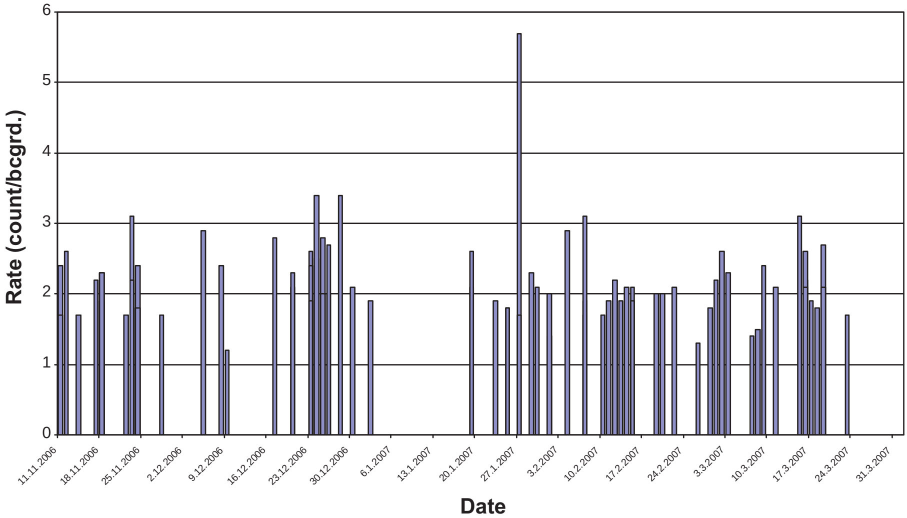

FIG. 5. Neutron alarms (counts/background).

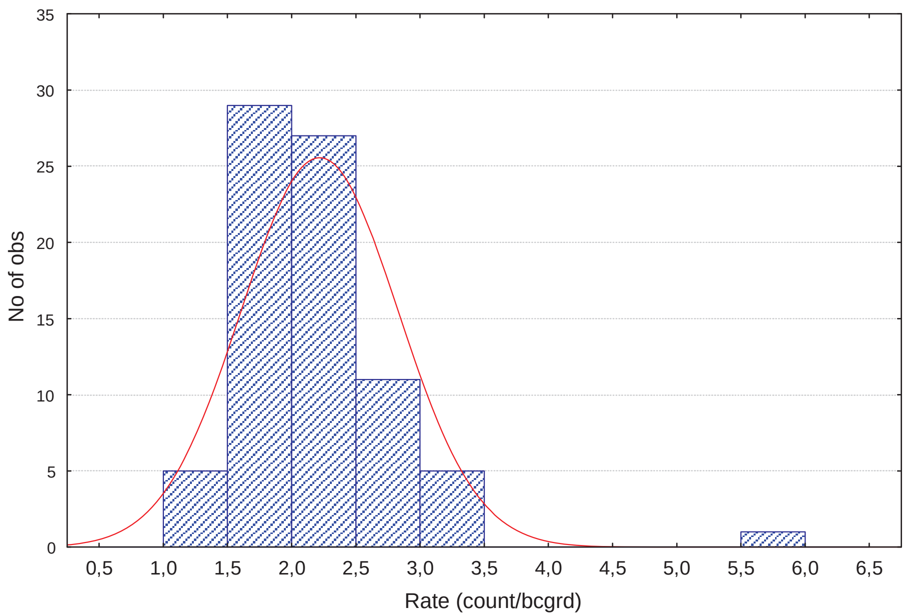

FIG. 6. Neutron alarms.

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ISTC CONTRIBUTION TO THE GLOBAL CHALLENGE OF ILLICIT TRAFFICKING OF FISSILE MATERIAL

Unique technical solutions from the Russian Federation–CIS aiming at non-proliferation[*]

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Abstract

The International Science and Technology Center (ISTC) is an intergovernmental organization created in 1992 by the Russian Federation, the European Union, the USA and Japan, located in Moscow, for non-proliferation purposes, which the Republic of Korea, Norway, Canada and most of the former Soviet republics joined afterwards. The mission of ISTC is to support the non-proliferation of technologies linked to weapons of mass destruction (WMD) by redirecting former Soviet weapons scientists, engineers and technicians to peaceful research, thus preventing the drain of sensitive knowledge and expertise from the Russian Federation and other Commonwealth of Independent States (CIS) countries to countries of concern. The core activity of the Center consists of funding individuals performing science and technology projects in the Russian Federation and CIS covering different areas, to a large extent in nuclear energy, biotechnologies, physics, nanotechnologies and solutions to environmental problems. Among the wide range of funded projects and other supportive actions, a key topic has always been the improvement of nuclear safety, in particular, technologies aiming to mitigate and avoid illicit trafficking of fissile material. Based on proven internal strengths and enough critical mass, ISTC support to this global threat has been considered of prior interest to the parties and chosen security as a topic for the ISTC Programmatic Approach Initiative. It offers the opportunity to focus on S&T related to this specific field (there are nine more) and to employ best practices from the past to future ISTC activities. The development of a targeted initiative on security would provide resources to ease ISTC beneficiaries (i.e. the WMD complex personnel in the Russian Federation/CIS) to reorient their activity in a more sustainable way by facilitating a platform for collaborative research to solve global society needs.

[*] The opinions expressed in this paper are the sole responsibility of the authors and may not necessarily correspond to the policy of the Center or the parties.

The International Science and Technology Center (ISTC) is an intergovernmental organization created in 1992 by the Russian Federation, the European Union, the USA and Japan, located in Moscow for non-proliferation purposes, which the Republic of Korea, Norway, Canada and most of the former Soviet republics joined afterwards. Switzerland is expected to formally join the Center in 2008. The mission of ISTC is to support the non-proliferation of technologies linked to weapons of mass destruction (WMD) by redirecting former Soviet weapons scientists, engineers and technicians to peaceful research, thus preventing the drain of sensitive knowledge and expertise from the Russian Federation and other Commonwealth of Independent States (CIS) countries to countries of concern due to their involvement in proliferation programmes.

The core activity of the Center consists of funding individuals performing science and technology projects in the Russian Federation and CIS covering different areas (Table 1). The generalist philosophy of the Center (through a permanent open call for proposals) has not hampered the funding parties from prioritizing, to a large extent, in specific technological fields, namely biotechnologies, physics, nuclear energy, solutions to environmental problems and nanotechnologies. Among the wide range of funded projects and other supportive actions, a key topic has always been the improvement of nuclear safety, in particular, technologies aiming to improve safeguards, and mitigate and avoid illicit trafficking of fissile material.

Based on proven internal strengths and enough critical mass, ISTC support to this global threat has been considered of prior interest to the parties and chosen security as a topic for the ISTC Programmatic Approach Initiative. It offers the opportunity to focus on S&T related to this specific field (there are nine more) and to employ best practices from the past to future ISTC activities. The development of a targeted initiative on security would provide resources to ease ISTC beneficiaries (i.e. the WMD complex personnel in the Russian Federation/CIS) to reorient their activity in a more sustainable way by facilitating a platform for collaborative research to solve global society needs.

The technologies developed by ISTC projects cover a wide range of methods and approaches to solve the threat or, at least, reduce the likelihood of the challenge for security and counterterrorism caused by illicit trafficking of fissile materials. An overview of the ISTC project portfolio on this topic reflects the contrasted experience of unique technological capabilities which are accessible through the ISTC framework after 13 years of operation. It consists of over 50 projects with a budget close to $15 million (out of 2000 funded projects with a budget of over $780 million). The typical stage of technological development of the ISTC projects in this area is close to market and commercialization, including design and tests of prototypes.

The identified cluster in the Russian Federation is compounded by world class research institutes, in the past linked to military programmes, which had the chance to redirect their outstanding scientific skills and unique facilities toward solving such challenges to humankind as global security and combating terrorism. Some prestigious research institutes from the Russian Federation specialized in nuclear physics. The presentation intends to provide an overview of activities performed by VNIIEF (Sarov), VNIITF (Snezhinsk), VNIIA, MEPhI, ITEP and NIIIT (Moscow), Budker INP of SB RAS (Novosibirsk), Khlopin Radium Institute (St. Petersburg), among others, aiming to combat the threat of illicit trafficking; to present their achievements and capabilities in combating it and to detect the unauthorized movement of radioactive material at borders or other locations; to disseminate innovative solutions for interdiction or seizure of radioactive material, including nuclear forensics, and for improvement of transport security; and to develop and implement methods for risk assessment of nuclear incidents and modelling threats, patterns and trends, emergency situations and vulnerabilities, as well as the development of tools for crisis management.

The Center has also served to design and implement tailor-made solutions and projects to strengthen the physical protection of nuclear facilities in CIS. Among others, ISTC funding parties have contributed to mitigating risks in the Mayak plant (Ozersk, Russian Federation), the Joint Institute of Energy and Nuclear Research Sosny (Minsk, Belarus) and experimental reactors of Kazakhstan's National Nuclear Center (Alatau and Kurchatov).

In addition to R&D, the Center manages other programmes aimed at assisting in the accomplishment of its mission. In particular, the paper draws attention to the ISTC Partner Program in which an entity from a funding party (whatever its condition or nature) receives all the advantages and privileges when deciding to fund a project. Among others, ISTC has the privilege to pay tax free grants to individual participants, to be exempt from customs duties, to minimize overheads (3–10% of budget), to reduce problems linked to export control due to ex ante so-called host governance concurrence. In principle, only business partners are charged a 5% fee for project management to monitor the project in situ.

To conclude, in accordance with the strategic vision of ISTC under discussion for the period until 2010, one of the tasks assigned to the Center will be to serve the international community by developing targeted initiatives to align the scope of activities closer to G8 priorities (e.g. counterterrorism, security, infectious diseases, alternative energies) and focus on R&D projects that actively support these priority areas. Naturally, the future strategy of ISTC intends to be consistent with other international actions as major parties take part in them; for example, the G8 Global Partnership against the Spread of

Weapons and Materials of Mass Destruction, and the European Union Strategy against Proliferation of Weapons of Mass Destruction, among others. The ISTC Partner Program facilitates the appropriate institutional and legal framework to conceal the performance of R&D projects, feasibility studies and technological demonstration contributing to combating illicit trafficking of nuclear materials with the non-proliferation mission assigned to the Center by easing sustainable opportunities to solve the needs of global society.

TABLE 1. SOME ISTC PROJECTS ON NUCLEAR MATERIAL ACCOUNTABILITY AND CONTROL AND AGAINST ILLICIT TRAFFICKING

No.	Title	Leading institute	Place	Funding, parties and time schedule
0040	System Design for Safeguarding Nuclear Materials Utilized at Complex Nuclear Facilities	Gosatomnadzor	Moscow, Russian Federation	\$815 000 (EU: \$271 667 + USA: \$271 667 + Japan: \$271 666) 1994–10–01 + 24 months
K-057	Creation of System for Storage, Operative Control and Physical Protection of Nuclear Materials and Ampoule Sources of Ionizing Radiation (ASIR) on “Baikal-1” Stand Complex Meeting the International Requirements of Radioactive Materials Control	RK NNC IAE	Kurchatov, Kazakhstan	\$700 000 (USA) 1996–06–01 + 24 months
0560	Development of a Computerized Nuclear Control and Accounting for Implementation in Russian Facilities	VNIIEF	Sarov, N. Novgorod reg., Russian Federation	\$200 000 (USA) 1997–09–01 + 41 months

TABLE 1. SOME ISTC PROJECTS ON NUCLEAR MATERIAL ACCOUNTABILITY AND CONTROL AND AGAINST ILLICIT TRAFFICKING (cont.)

No.	Title	Leading institute	Place	Funding, parties and time schedule
0596	Development of Technology of Non-Destructive Identification of Fissile Materials in Control Stations	MIFI + VNIIA + Inst. Biophysics	Moscow, Russian Federation	$490 000 (EU: €245 000 + USA: $245 000) 2000–01–01 + 41 months
0772	Development of Methods for Creation and Registration of Unique Recognizable Optical Images for Nuclear Material Control	VNIITF	Snezhinsk, Chelyabinsk reg., Russian Federation	$300 000 (USA) 1998–06–01 + 29 months
1356	Development of a Nuclear Materials Control and Accounting System Model for Complex Nuclear Facilities	FEI (IPPE) +VNIIA (Automatics) +VNIINM Bochvar + Siberian ChemicalKombinat (SKhK)	Obninsk, Kaluga reg., Russian Federation	€378 860 (EU) 2001–03–01 + 27 months
1449	Theoretical-Calculation and Experimental Support of Safe Transportation and Storage of Excess Weapons-Grade Plutonium Transferred to the Civil Sphere of Utilization	VNIITF + Keldysh Institute of Applied Mathematics + MIFI	Snezhinsk, Chelyabinsk reg., Russian Federation	€378 680 (EU) 2001–01–01 + 41 months
1622	Development of the Technology for Detecting Fissile Materials in Passenger Luggage on the Basis of the Active Methods	VNIIA (Automatics) + NIIIT (Pulse Techniques)	Moscow, Russian Federation	$200 000 (USA) 2000–03–01 + 18 months
1831	Application of Non-Radiation Methods for Nuclear Materials Accounting, Control and Identification	VNIIEF	Sarov, N. Novgorod reg., Russian Federation	$294 090 (USA) 2002–02–01 + 24 months

TABLE 1. SOME ISTC PROJECTS ON NUCLEAR MATERIAL ACCOUNTABILITY AND CONTROL AND AGAINST ILLICIT TRAFFICKING (cont.)

No.	Title	Leading institute	Place	Funding, parties and time schedule
1919	Tamper Indicating Device Complex Development and Implementation within NM Protection, Control and Accountability System (MPC&A)	VNIIEF	Sarov, N. Novgorod reg., Russian Federation	$150 000 (USA) 2002–06–01 + 21 months
2062	Development of Data Acquisition and Processing System of Integrated Physical Protection System MARS-2000	VNIITF + FEI (IPPE) + Russian Research Certification Center	Snezhinsk, Chelyabinsk reg., Russian Federation	$199 995 (USA) 2002–04–01 + 27 months
2074	Development of a Guidebook on the Dual-Use Nuclear Commodity Control List for Russian Export Control System Application	VNIITF + FEI (IPPE) + TRINITI + State Unitary Enterprise P "Electrochemical Plant"	Snezhinsk, Chelyabinsk reg., Russian Federation	(US partner) 2001–11–01 + 24 months
2585	Development of the Method for Characterization of the Samples, Containing Spontaneously Fissioning Radionuclides, by Measuring Fission Products Gamma-Radiation (for the System of NM Control and Accountability of the Federal State Unitarian Enterprise "PA"Mayak")	MIFI + Mayak + Bochvar	Moscow, Russian Federation	$400 000 (EU: €160 000 + Canada: $200 000) 2004–12–01 + 41 months

TABLE 1. SOME ISTC PROJECTS ON NUCLEAR MATERIAL ACCOUNTABILITY AND CONTROL AND AGAINST ILLICIT TRAFFICKING (cont.)

No.	Title	Leading institute	Place	Funding, parties and time schedule
2637	Developing the Experimental Model of the Device for Nuclear Material Detection by Photoneuton Technology, Optimization of Device Detection Parameters to Meet the Solution of Non-Proliferation Problems	Kurchatov Institute	Moscow, Russian Federation	\$141 000 (Canada) 2004–12–01 + 24 months
2732	Development of a Technology for Seeking a Neutron Source in Compactly Built-Up Urban Areas and Design of a Prototype Survey Radiometer	NIIIT (Pulse Techniques)	Moscow, Russian Federation	\$202 950 (USA) 2004–12–01 + 24 months
2978	Digital Technology for the Detection and Control of Fissile Materials in Devices with Pulsed Neutron Sources	MIFI + NIIIT + VNIIA	Moscow, Russian Federation	\$439 900 (EU: €165 376 + Canada: \$219 950) 2005–10–01 + 30 months
3106	Development of Multi-Purpose Technology for Detection of Toxic, Explosive and Radioactive Chemical Compounds and Inactivation of Organisms	Khlopin Radium Institute	St. Petersburg, Russian Federation	€146 690 (EU) 2007–05–01 + 36 months
3390	Calculation-Theoretical Investigation of the Possibilities of Protected HEU Detection	VNIIEF	Sarov, N. Novgorod reg., Russian Federation	\$196 000 (Canada) 2007–04–01 + 36 months
3534	Calculation-Theoretical Investigation of the Possibilities of Protected HEU Detection	Khlopin Radium Institute	St. Petersburg, Russian Federation	\$520 000 (EU: €197 613 + Canada: \$260 000) 2007–07–01 + 36 months

TABLE 1. SOME ISTC PROJECTS ON NUCLEAR MATERIAL ACCOUNTABILITY AND CONTROL AND AGAINST ILLICIT TRAFFICKING (cont.)

No.	Title	Leading institute	Place	Funding, parties and time schedule
3596	Development of Approaches for Generation of a Database on Research Reactors Fuel for Counteracting Illicit Turnover of Nuclear Materials	VNIITF	Snezhinsk, Chelyabinsk reg., Russian Federation	(US partner) 2007–04–01 + 9 months
3667	Nuclear Materials Detector	Ioffe Institute + Khlopin Radium Institute + Krasnaya Zvezda	St. Petersburg, Russian Federation	(US partner) 2007–04–01 + 24 months
B-1177	Development of Conceptual Design for Upgrading the Physical Protection System and Material Controls Accounting (PPS&MCA) JIPNR-Sosny	Joint Institute of Energy and Nuclear Research	Sosny, Minsk, Belarus	$100 830 (USA) 2007–02–01 + 9 months
3705	Examination of Functional Capabilities of Electronic Seals at the RFNC VNIITF, Enterprises of the Ural Region, and NNC of the Republic of Kazakhstan	VNIITF + RK NNC INP	Snezhinsk, Chelyabinsk reg., Russian Federation	For funding consideration $178 000 18 months

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NUCLEAR REGULATORY COMMISSION'S PROGRAMME TO MINIMIZE AND DETER THE POTENTIAL THREAT RELATED TO ILLICIT TRAFFICKING

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Abstract

The US Nuclear Regulatory Commission (NRC) has specific policy and regulatory requirements to minimize the potential for unauthorized acquisition, possession, use, transfer or disposal of licensed radioactive material. NRC licensees must report to the NRC all losses of licensed material to ensure that the proper perspective related to safety and security is evaluated. NRC's licensing and inspection programme provides the public with assurance that licensees are inspected, and are operating safely and in compliance with the regulatory, licence or order requirements. In the event that the NRC determines that the licensee failed to comply with regulatory requirements, the NRC has a multitude of enforcement sanctions that can be implemented at its discretion. The NRC has a specific branch that, in cooperation with other federal agencies, assesses, monitors and shares intelligence information related to potential malicious use, illicit trafficking and/or other uses of licensed material that may pose a threat. The NRC provides information to the IAEA's Illicit Trafficking Database (ITDB) and believes the concept of the database complements the US Government's global initiative to combat nuclear terrorism. The NRC values international information sharing and believes more work is needed in this important area. The NRC has some ideas about increasing the overall effectiveness of the ITDB and will raise them in the appropriate forum.

1. NUCLEAR REGULATORY COMMISSION REGULATORY AUTHORITY

Under the auspices of the US Atomic Energy Act, the US Nuclear Regulatory Commission (NRC) has the authority and responsibility to regulate by-product, source and special nuclear material to ensure that the public's health and safety, and the environment are adequately protected. In its mission, the NRC promotes the common defence and security of its regulated activities by providing assurance that material is used for its intended purposes. Section 274 of the US Atomic Energy Act provides a statutory basis under which the NRC relinquishes to the states, portions of its regulatory authority to license and regulate by-product materials (radioisotopes); source materials (uranium and thorium); and certain quantities of special nuclear materials. The mechanism for the transfer of the NRC's authority to a state is an agreement signed by the governor of the state and the chairman of the commission, in accordance with section 274b of the Act. Currently, the NRC has granted 34 states (agreement states) the authority to regulate radioactive material, as mentioned. These agreements include virtually identical reporting requirements to the state, and subsequently to the NRC.

2. NRC POLICY AND REGULATORY REQUIREMENTS SPECIFIC TO LOST/STOLEN LICENSED MATERIAL

The NRC has specific policy and regulatory requirements regarding the safety and security of licensed material that provides assurance that radioactive material is used safely and controlled in a manner to alleviate or minimize the potential for unauthorized acquisitions, possession, use, transfer or disposal.

The NRC and the agreement states have an extensive infrastructure to ensure the safety and security of licensed material that utilizes a threat and risk informed, performance based approach. Regulatory requirements require licensees to report all losses/theft of licensed material. Reporting timeliness is based on risk significance, e.g. type and activity of material. Significant losses and thefts are required to be reported immediately, thus providing the NRC and agreement states with the ability to evaluate the details of the material event and determine whether an immediate response is necessary.

The NRC requires licensees to ensure that licensed material is transferred in accordance with regulatory requirements (must be transferred to a licensed entity) and requires records to be kept. The NRC has implemented the IAEA Code of Conduct [1, 2] recommendations pertaining to importation or exportation of IAEA Category 1 and 2 quantities of radioactive material identified in 10 CFR Part 110, which requires a specific NRC licence.

The NRC has a 24 h operations centre that receives event calls and notifies the appropriate management and technical staff to allow for immediate evaluation and a potential response. In addition, the NRC has a branch that specializes in monitoring intelligence, and analysing and assessing potential threats related to malicious use, theft or trafficking of licensed material.

Through established channels, the branch can communicate with a multitude of federal and state law enforcement officials if warranted.

NRC policy defines metrics for both the NRC and the agreement state licensees to ensure that losses and/or theft of licensed material is prioritized appropriately and receives immediate attention as warranted, for example, losses of risk significant licence material (IAEA Code of Conduct Category 1 and 2 material or certain quantities of special nuclear and source material).

In order to ensure that specific metrics are evaluated appropriately and reported to Congress on an annual basis, e.g. losses/thefts of licensed material, the NRC has a nuclear materials and events database (NMED) that provides a mechanism to trend, track and compile material events of all types specific to non-compliance with regulatory requirements. In addition, the NRC has specialized staff that evaluate, on a daily basis, all reported events for significance, commonality, generic implications and potential for unauthorized activity. The NRC also utilizes a separate database that contains information regarding licensees' possession of IAEA Category 1 and 2 sources in order to remain cognizant of licensees that possess risk significant material.

Prior to 11 September 2001, the NRC based its licensing and inspection programme on the premise of health and safety. This is not to say that security of material was not factored into the programmes, but that the major emphasis was to ensure the safe use of licensed material and to provide adequate protection of the public's health and safety, and the environment. Subsequent to 11 September 2001, the NRC re-evaluated its programme to ensure that proper emphasis was put on security. Based on the evaluation, the NRC concluded that it was imperative to impose stricter requirements on licensees to ensure that security of licensed material received more focus and attention, and that stricter security requirements are directly correlated with protection of the public's health and safety.

Because of the paradigm shift to include more emphasis on security over licensed material, the NRC issued security orders to nuclear and radioactive material licensees. In particular, greater emphasis was placed on licensees that possessed IAEA Code of Conduct Category 1 or 2 material as well as licensees that possessed nuclear material above a specific threshold. The security orders (or legally binding requirements) were issued by the NRC and the agreement states to more than 3000 licensees (manufacturers and distributors, panoramic irradiator licensees and licensees possessing IAEA Category 1 or 2 material) and imposed specific requirements on these licensees to provide for access control, delay, detection, assessment and response to unauthorized access to IAEA Category 1 or 2 material. Additionally, the security orders imposed information security requirements on detailed information generated by the licensee that describes the physical protection of radioactive material in quantities of concern.

The security orders issued by the NRC and the agreement states provide for stricter security over licensed material when in transport, storage and when in use. Specifically, the orders required licensees to provide for physical security, control and real time security monitoring to thwart/prevent theft. The orders also required that personnel authorized unescorted access to risk significant material be approved via a background security review. The NRC issued additional security measures for shipments of IAEA Category 1 quantities of material, known as material in quantities of concern (RAMQC), to ensure that the material makes it to its intended destination. Shippers of RAMQC must be subject to background security evaluations and must ensure that specific security measures are implemented to provide adequate assurance that security precautions are in place to thwart and prevent theft.

3. NRC LICENSING AND INSPECTION PROGRAMME

The NRC typically conducts unannounced, periodic inspections of licensed activities, using formal guidance and inspection procedures to examine whether licensees are performing activities in accordance with regulatory, licence or order requirements. The NRC subsequently issues inspection reports to document inspection findings. These inspection reports may contain enforcement actions and follow-up inspection items. The NRC makes the results of inspections available for public review through its electronic document retrieval system.

The NRC's training and qualification programme requires licence reviewers and inspection staff to be trained in all facets of applicable requirements, guidance, uses and types of material specific to the type of licensee. In addition, licensing and inspection staff received specific training related to the implementation of the new security requirements that were issued to licensees via security orders.

Prior to issuing a licence to possess and use licensed material, the NRC's trained specialists evaluate the applicant's request and conduct a thorough, comprehensive review to determine the validity of the licence and the applicability of use. In addition, new applicants and licensees requesting to increase possession of certain risk significant material must be inspected prior to receiving licensed material to ensure that the material will be used as authorized. Additionally, all licensees or applicants wanting to possess or use risk significant material must implement the security orders prior to being provided access authorization to the material. In addition, personnel employed by the licensee that need to access risk significant licensed material must also be subject to a security background check.

The NRC's inspection frequency is based on the type of licensee, possession limits and uses of licensed material, i.e. safety significance. For example, a licensee that is authorized and possesses IAEA Category 1 or 2 sources will be subject to an inspection frequency corresponding to the inherent risk associated with the use and licensed material, for example, radiography inspection frequency is once per year. Currently, the NRC is considering revisions to the inspection frequency to include security considerations as well as health and safety considerations.

4. NRC ENFORCEMENT POLICY

The NRC has an established enforcement policy and process that is designed to reinforce that the licensee adheres to the regulatory requirements related to illegal transfer, disposal or loss of the licensed material. The NRC's enforcement jurisdiction is drawn from the Atomic Energy Act of 1954, as amended, and the Energy Reorganization Act of 1974, as amended. Subpart B of 10 CFR Part 2 of NRC regulations set forth the procedures the NRC uses in exercising its enforcement authority. The policy is used as a basis to emphasize the importance of compliance with regulatory requirements, and to encourage the licensee to promptly identify and take prompt, comprehensive correction of violations.

Licensees are required to comply with all regulatory requirements, licence conditions and orders. Violations are identified through inspections and investigations. If significant enough, failure to comply with the regulatory requirements could entail severe enforcement sanctions against the licensee including levying civil penalties, suspending/revoking the licence, removing individuals from licensed activities and possible prosecution by the Federal Government that could lead to a jail sentence.

5. THREAT ASSESSMENT

For approximately 30 years, in cooperation with the intelligence and law enforcement communities, the NRC has had a small group monitoring intelligence and other threat issues that could affect regulated activities. Among the many issues that the team monitors are cases of malicious use of radioactive material, illicit trafficking of radioactive material, attempted theft of radioactive material and radioactive material that is otherwise outside of legitimate control. The branch also monitors cases of illicit trafficking overseas, to determine trends as well as to understand the methods by which material is obtained, in order to determine whether the NRC's DBTs or other regulations require modification. In cases in which NRC licensed or agreement state licensed material is involved with one of these aforementioned acts, NRC staff rapidly coordinate with federal agencies as well as local authorities.

6. US ILLICIT TRAFFICKING AND SUGGESTIONS REGARDING INFORMATION SHARING

As mentioned previously, the NRC and the agreement states have an extensive infrastructure to ensure the safety and security of licensed material. This infrastructure includes defined metrics related to lost or stolen licensed material, an evaluation of all reported losses and/or thefts to determine whether further action is necessary, and trending analyses to determine whether there is a potential to aggregate certain types of devices that are commonly stolen such as portable gauging devices.

As part of this infrastructure, the NRC provides information to the IAEA's Illicit Trafficking Database (ITDB) [3] and believes that the concept of the database complements the US Government's global initiative to combat nuclear terrorism, the Convention on the Physical Protection of Nuclear Material [4], United Nations Security Council Resolution 1540 [5] and the International Convention for the Suppression of Acts of Nuclear Terrorism [6].

International cooperation to prevent smuggling is essential and predicated on information exchange. Information exchange is needed to facilitate law enforcement cooperation and to craft effective strategies to prevent smuggling and terrorism. The ITDB is a useful mechanism to share information, however, such mechanisms could be even more effective if they promoted a better understanding of this widespread and threatening phenomenon.

The NRC believes that the database should focus greatest attention on incidents of malicious smuggling. Many databases collect a broad scope of information on radioactive material outside of legitimate control. While collecting a broad set of data helps to ensure that all trafficking incidents are reported, incidents vary in significance and need to be characterized accurately. The theft of a Category 2 ^{60}Co source is fundamentally different from the theft of a vehicle with a Troxler gauge. While traffickers may not understand the difference between a Category 1 and a Category 5 source, the Code of Conduct helps governments identify what sources are of greatest concern and can help to more accurately characterize trafficking incidents.

Ideally, information exchange programmes should help to identify which trafficking incidents pose threats, what motivates traffickers and what are the most effective measures for preventing trafficking.

7. CONCLUSION

The NRC has specific policy and regulatory requirements to minimize the potential for unauthorized acquisition, possession, use, transfer or disposal of licensed radioactive material. Subsequent to 11 September 2001, the NRC focused more attention on the security of licensed material and re-evaluated its security policy and issued security orders to licensees possessing and/or shipping risk significant material. The NRC's licensing, inspection and enforcement programme provides assurance that material is being used as authorized and in accordance with the regulatory and licence requirements. The NRC's specialized branch that focuses on threat assessment and intelligence complements other NRC activities and ensures that the NRC's DBTs and other regulatory requirements meet the current threat environment.

As a result of the NRC's programmes, while some thefts of material have occurred, the data indicate that most cases are not involved with illicit trafficking of malicious intent. The NRC supports the premise of the ITDB and other information exchange efforts, but believes that more work is needed in this area to improve their usefulness and assist other regulatory and government bodies. The NRC is willing to assist the IAEA and other Member States in moving towards this objective.

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[5] United Nations Security Council Resolution 1540, United Nations, New York (2004).

[6] International Convention for the Suppression of Acts of Nuclear Terrorism, United Nations, New York (2005).

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A MULTI-COUNTRY PROJECT ON COMBATING ILLICIT TRAFFICKING OF NUCLEAR MATERIALS

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Abstract

The international community is gravely concerned about the threat associated with illicit trafficking of nuclear and other radioactive materials, and the possible use of the latter for terrorist purposes. A number of international resolutions and initiatives have addressed this issue, and international institutions as well as individual States are implementing measures for combating illicit trafficking and for preventing nuclear terrorism. In the framework of the European Commission's Technical Assistance to the Commonwealth of Independent States (TACIS) programme, the Joint Research Centre (JRC) has proposed a regional approach in the form of a Multi-country Project for efficiently implementing measures for combating illicit trafficking of nuclear and radioactive materials in the Russian Federation, Ukraine, Georgia, the Republic of Moldova and Azerbaijan.

1. INTRODUCTION

Following the breakdown of the Soviet Union, the international community realized the importance of nuclear safety and security issues in the Commonwealth of Independent States (CIS). The 1992 G7 summit in Munich, Germany, decided to give the leadership to the European Union to address the corresponding problems. Upon the request of the member States, the European Commission created the Technical Assistance to the Commonwealth of Independent States (TACIS) programme.

In a first step, projects tackled the most urgent problems related to the safety of Soviet design nuclear power plants. In September 1994, the European Commission decided to include projects for establishing more reliable safeguards systems in the TACIS programme. While the US safeguards support focused on the removal and physical protection of weapons grade material, the European Commission approach was centred on the civil fuel cycle.

In a further step, activities related to nuclear security were also developed, essentially dealing with analytical capabilities for characterizing nuclear material intercepted from illicit trafficking. In their 1996 meeting in Moscow, Russian Federation, the G8 States expressed their will to combat illicit trafficking of nuclear material and initiated the foundation of the Nuclear Smuggling International Technical Working Group (ITWG). The Institute for Transuranium Elements (ITU), as a co-chair (together with the Lawrence Livermore National Laboratory, CA, USA) took the initiative to develop a model action plan which provides an integrated and common response to illicit trafficking based on prevention, detection and response.

United Nations Security Council Resolution 1540 (April 2004), the proliferation security initiative (PSI, launched in 2003) and the Global Initiative to Combat Nuclear Terrorism (July 2006), reaffirmed the grave concern of the international community about the threats associated with proliferation issues and with illicit trafficking. The political will needs to be translated into concrete measures, some of which may be of an organizational nature while others will be of a technical nature. The development and implementation of the latter requires technical expertise and competence in this specific area. Also within the framework of the TACIS programme, increased attention is given to the issue of illicit trafficking.

2. TACIS SUPPORT PROGRAMME

Within the TACIS support programme 1994–2004, nine projects were implemented in three beneficiary countries (Russian Federation, Kazakhstan, Ukraine). Related to the first step of the model action plan, the projects focused mainly on the prevention of the diversion of nuclear materials. Consequently, a series of projects improving nuclear material accountancy and control (NMAC), analytical techniques, containment and surveillance, and a system of independent verifications were implemented.

The projects were coordinated by two JRC institutes: ITU and the Institute for Systems Information and Safety (ISIS) that was later renamed the Institute for the Protection and Security of the Citizen (IPSC). Both institutes have more than three decades of experience in dealing with nuclear material and in all safeguards related issues. They provide support to the Directorate General for Transport and Energy (DG TREN) in implementing the Euratom Treaty, to the IAEA for the Treaty on the Non-Proliferation of Nuclear Weapons and to the Directorate General for External Relations (DG RELEX) and to the Europe Aid Cooperation Office (DG AidCo) through their participation in the TACIS programme.

In the TACIS support programme 2005–2012, 14 projects within seven countries (Russian Federation, Kazakhstan, Ukraine, Georgia, Armenia, the Republic of Moldova and Azerbaijan) continue to deal with safeguards issues, tracking nuclear material by improving the NMAC of the fuel cycle to prevent diversion, but also address new challenges. In addition to completing previous projects, and reinforcing and sustaining past activities, the European Commission is currently supporting programmes of deploying detection capabilities, and the development and implementation of proper response mechanisms in accordance with international standards.

Obviously, illicit trafficking is a border problem; hence, it calls for a coordinated international response. In particular, considering the outside borders of the future enlarged European Union, a corresponding Multi-country Project involving the Russian Federation, Ukraine, the Republic of Moldova, Georgia and Azerbaijan for combating illicit trafficking has been set up. The overall objective of the proposed Multi-country Project is to combat illicit trafficking across the selected countries using the platform of a common project. This will significantly strengthen the non-proliferation regime and contribute to the fight against nuclear and radiological terrorism in the region. The complementary scientific/technical competences of the two JRC institutes will be transferred and applied to these combating illicit trafficking issues. The selected regional approach aims at strengthening the cooperation between participating countries and fostering a global response to illicit trafficking through a common integrated procedure.

3. PROJECT STRUCTURE

After gathering a first experience in nuclear forensic investigations in the first half of the 1990s, it was realized that a comprehensive approach needed to be developed. ITU, as a co-chair of the ITWG, took the initiative to develop a model action plan within the ITWG. Today, the JRC strategy for nuclear security is based on the model action plan. This plan provides an integrated and common response to illicit trafficking and makes use of a three step approach (prevention of the diversion of nuclear and radioactive materials, detection of any unauthorized movement of materials and response to cases of illicit trafficking), including feedback and lessons learned to enhance the deficient situation at the origin of the incident (i.e. the place of theft or diversion of the nuclear or radioactive material).

The Multi-country Project consists of five individual subprojects, taking into account the particular regulatory situation, and the technical and administrative infrastructure of every country included. However, since many common objectives exist, the Multi-country Project will combine all the necessary efforts in common tasks, e.g. common workshops and training to achieve more regional contacts or common model border exercises to stimulate more bilateral information exchange. This will ensure the utilization of synergistic effects. The project structure and the main elements are shown in Table 1.

A fact finding mission in each country provides information on other cooperative activities, on the relevant national regulations, and the authorities and institutions involved in incidents involving nuclear and radioactive materials, as well as on the available technical infrastructure.

Based on the outcomes, the development of a national response plan, Response to Illicit Trafficking of Nuclear Material (RITNUM) will be a key deliverable of the project for each participating State. RITNUM describes the roles and responsibilities of each actor involved in the response to a case of illicit trafficking. Based on RITNUM, the first responders will be provided with the necessary equipment and trained on both the use of the delivered equipment and the procedure that applies from detection to response. Measurement experts will be trained at JRC premises and mobile measurement capabilities will be established. Where appropriate, the existing analytical capabilities in the laboratory will be complemented or upgraded. The well established nuclear forensic capabilities at ITU can be made available for providing nuclear forensic support through the signature of an agreement on joint analysis at ITU. Demonstration exercises shall be held for practising the provisions foreseen in RITNUM, and for optimizing the protocols and procedures.

4. INTERNATIONAL COLLABORATION

In 2003, the European Council decided to finance the first Joint Action (JA) to be implemented by the IAEA in the frame of its programme against the proliferation of weapons of mass destruction. Two JAs are ongoing and a third one was submitted to the Council early in 2006. The first JA targeted the

TABLE 1. OVERVIEW OF THE ELEMENTS OF THE MULTI-COUNTRY PROJECT

	Russian Federation	Ukraine	Republic of Moldova	Georgia	Azerbaijan
1	Fact finding		Fact finding	Fact finding	Fact finding
2	Implementation of a model action plan and development of a RITNUM handbook		Implementation of a model action plan and development of a RITNUM handbook	Implementation of a model action plan and development of a RITNUM handbook	Implementatio n of a model action plan and development of a RITNUM handbook
3	Delivery of handheld isotope identifiers	Delivery of handheld isotope identifiers	Delivery of handheld isotope identifiers	Delivery of handheld isotope identifiers	
4	Model border crossing station (Kaliningrad)	Specific additional project	Model border crossing station	Implementation of stationary equipment	
5	Mobile laboratory	Mobile laboratory	Mobile laboratory		
6	Demonstration exercise	Demonstration exercise	Demonstration exercise	Demonstration exercise	Demonstration exercise
7			Upgrade of analytical laboratory capabilities	Upgrade of analytical laboratory capabilities	
8	Joint Analysis Agreement/ Memorandum of Cooperation	Joint Analysis Agreement/ Memorandum of Cooperation	Joint Analysis Agreement/ Memorandum of Cooperation	Joint Analysis Agreement/ Memorandum of Cooperation	Joint Analysis Agreement/ Memorandum of Cooperation
9	Maintenance of the NM database	Maintenance of the NM database			
10	Training	Training	Training	Training	Training
11	Workshop	Workshop	Workshop	Workshop	Workshop

Balkans, Central Asia and Caucasus areas while the second one focused on the Middle East and Africa. The JA aims to assess the situation in the individual countries and, based on the results, support the enhancement of nuclear security in the selected country by:

— Developing the necessary infrastructure including legal and regulatory framework;
— Improving physical protection;
— Reducing threats for other radioactive materials by, for example, identification, control and safe storage of orphan sources;
— Increasing the capabilities of detecting and responding to illicit trafficking of nuclear and radioactive materials at borders.

The ITWG provides an international forum for practitioners in nuclear forensics for advancing this new discipline in science. Furthermore, it serves as a platform for interaction between law enforcement, customs, regulatory bodies and nuclear forensics laboratories in order to assure information exchange and interdisciplinary, and inter-agency collaboration. At present, more than 20 States are represented in the ITWG, and international organizations (IAEA, Europol, INTERPOL, World Customs Organization, etc.) contribute to the activities of the ITWG.

A number of donor States operate support programmes in the area of combating illicit trafficking of nuclear materials. In order to efficiently use the funds available and to avoid duplication of efforts in recipient countries, the main actors agreed to establish an intensive and regular exchange of information. A strong focus was set on detection of nuclear and radioactive materials at borders and in late 2005, a dedicated Border Monitoring Working Group (BMWG) was established under the auspices of the IAEA. Beside the IAEA, the US Second Line of Defense (SLD), the European Commission (represented by the Joint Research Centre, DG RELEX, DG AidCo) and the Council of the European Union are members of the group. The BMWG coordinates the activities in the field with an integrated approach by country, identifying in particular the recipient institution of the support and possible harmonization of the technical assistance (including equipment and training).

5. CONCLUSIONS

The fight against illicit trafficking of nuclear and radioactive materials is a major international concern involving both national and international efforts.

The JRC regional approach, besides the enhancement of detection capabilities, strengthens the necessary collaboration between the concerned countries.

Based on its technical expertise and extensive experience in the field, the JRC provides relevant training to the services involved, in particular frontline officers, law enforcement services and laboratory experts. In particular, the JRC supports the implementation of standardized detection and response procedures in recipient countries by developing a national model action plan. When completed, this plan is assessed and validated through a demonstration exercise.

International coordination is assured to optimize the use of available resources between major donors (IAEA, US Department of Energy and the European Commission) to avoid duplication of efforts and to fill in the identified gaps to efficiently prevent nuclear and radiological events.

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AFGHAN CUSTOMS DEPARTMENT
Main points of five year strategic plan

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Abstract

Customs reform and modernization is essential for the economic progress of Afghanistan. The reform process aims at improving the organization so that it will have the correct structure, logical definition of roles, fair recruitment system, service conditions, accountability, conduct and disciplinary rules, training support and a built-in mechanism for the promotion of ethics in the staff. The paper provides an overview of the reform process, including overall goals; the strengths, weaknesses, opportunities and threats of the current situation; programme objectives; a performance evaluation of the five year plan; and project components of the first part of the reform programme, involving law and procedures.

1. INTRODUCTION

Customs reform and modernization is a sine qua non for the economic progress of Afghanistan. The reform process will ensure efficiency in the collection of revenue and in the prevention of illicit, dangerous or undeclared goods from entering the country. With better revenue realization, the Government will be enabled to meet its commitments to deliver better security, economic growth, democratic policies, a pluralistic society and a market based economy. A better quality customs service will improve trade flows.

The basic thrust of reforms will be to develop a customs system that minimizes leakage in revenue collection through rationalization of laws and automated processes. This system will help facilitate clearance of goods and reduce contact of officers with trade, thereby reducing the scope for corruption. Adoption of automated processes and international best practices for international transit of goods through its territories will help make Afghanistan a land bridge of the region.

The reform process will see the strengthening of the enforcement machinery of the Customs Department, which will create deterrence to duty evaders and curb smuggling of goods, including narcotics and environmentally hazardous goods. The Department will provide a level playing field to all importers and exporters to the extent that traders will not be permitted to wrongfully gain a market advantage by committing customs fraud. By developing a strong intelligence network, the Department will be able to play a major role in the coordination of intelligence with other security agencies.

The approach of the reform is not to confront traders but to enter into a partnership with them for better voluntary compliance with laws, which will benefit the traders by reducing their transaction costs.

Customs, due to its nature of operation, has a large body of officers and organizational issues are very important. The reform process aims at improving the organization so that it will have the correct structure, logical definition of roles, fair recruitment system, service conditions, accountability, conduct and disciplinary rules, training support and a built-in mechanism for the promotion of ethics in staff.

Customs operations are spread over a large geographical area and many customs offices. There is a shortage of office buildings, working space and equipment. The plan seeks to meet these requirements and their creation at an early date.

The Afghan Customs Department (ACD) has been entrusted with the additional responsibility of creating and operating facilities in inland clearance terminals and warehouses, though such an activity is not within the core competence of any customs organization. In view of the existing poor facilities, creation of the physical infrastructure of terminal buildings and cargo handling equipment assumes urgency in the interest of trade facilitation. The reform programme addresses the need for such infrastructural development and suggests an autonomous body with the necessary technical skills to assume the civil works procurement and management of these facilities.

2. OVERALL GOALS

The goal of the ACD is to collect revenue for the Government with the utmost efficiency so as to meet revenue targets laid down by the Government and to facilitate trade both by faster clearance of goods and by providing state of the art facilities for warehousing and terminal operations.

The ACD aims at creating a strong enforcement machinery for curbing evasion of customs duty and preventing smuggling of goods. The aims mentioned are proposed to be met by establishing a healthy customs–business partnership for increasing voluntary compliance and reducing transaction costs for traders. The ACD will strengthen interdepartmental coordination in the field of enforcement of different laws as well as for economic governance.

3. CURRENT SITUATION ANALYSIS

3.1. Strengths

In the past four years, the following milestones have been reached with donor assistance:

— Customs legislation, based on a foreign model, enacted to give a legal basis to customs operations;
— Adoption of a harmonized system for the classification and coding of goods used by nearly all trading nations;
— Automated System for Customs Data (ASYCUDA), developed by UNCTAD, introduced a declaration processing system at Kabul customs on a pilot basis for computerization of customs assessment and processing;
— Computerization of transit procedure with ASYCUDA at Torkham–Jalalabad–Kabul, Islam Qala–Heart and Heyratan–Mazar corridors. The use of ASYCUDA at these stations has resulted in almost 100% compliance by transiting vehicles;
— Import related exemptions policy, practices and procedures were formed;
— Automated data collection and production of customs statistics introduced in major customs offices;
— Customs brokers programme introduced;
— Procedures and tariff for travellers simplified;
— A plethora of customs declaration systems simplified but further modernization needed;
— IT related equipment, power supply (generators), uniforms, vehicles and telecommunications equipment and similar supporting goods acquired;
— Afghanistan accepted as a full member of the World Customs Organization.

3.2. Weaknesses

Several weaknesses exist, including the following:

— The condition of customs offices in many places, and equipment/ stationery, etc. available in nearly all of them, is highly unsatisfactory as many offices are built of mud and are lacking electricity and water;
— The physical infrastructure available in most customs terminals and warehouses is highly inadequate with few civil works and no cargo handling equipment for the purpose of providing service to trade. The cargo handling and warehouse operations are supervised by customs, though such work is not within the core competence of customs officers;
— Introduction of automated processes through adoption of ASYCUDA modules in any customs office will need sustained efforts at retraining the customs officials to work with automated processes which are very different from manual processes;
— Customs legislation needs to be reviewed in conformity with the working conditions in Afghanistan, especially for the purposes of automation, fines, penalty, appeal, enforcement, regional opportunity zones customs, etc.;
— Customs needs to create the capability of generating analysis reports on the basis of data available in customs offices, for assisting the Government in formulation of its customs tariff policy and for making development plans;
— Departments other than customs (Ministry of Interior, Ministry of Commerce and Industry, Ministry of Health, etc.) interfere with the clearance of imported/exported goods or goods in transit, resulting in severe harassment to trade and delay in clearances;
— The ACD has weak control over staff operating in provincial customs offices, as local authorities have been unduly interfering in customs operations;
— The enforcement machinery is not adequately equipped to meet the challenge of smuggling and evasion of duty. The weak areas of the enforcement regime are lack of enabling laws, staff deployment, availability of equipment and training;
— There is serious under capacity among customs staff, as selection is not on the basis of competitive examination. Staff lack training for meeting the plan objectives;
— There is no scheme for giving rewards or other incentives to recognize and encourage good performance nor are there any administrative powers with the ACD to discipline misconduct or suppress delinquent behaviour;
— There is no customs audit machinery within the ACD. Customs needs to acquire the capability of inspection and audit, develop necessary

procedures and ensure their harmonized application in different customs offices.

3.3. Opportunities

Several opportunities exist, including:

— Customs is recognized as a major source of revenue and collection has grown over the last four years, from AF 4.5 billion in 2003 to AF 9.2 billion in 2005 and AF 15.4 billion in 2006. The department is instrumental in collecting other duties/taxes as well and its net contribution to Government coffers is nearly 70% of all Government revenues. Bringing greater efficiency to the system is presently the most certain way for the Government to augment revenue;
— The achievements of the ACD in the past four years are considerable. Donors have enough evidence before them to conclude that assistance in the projects of the ACD bring high dividends to the Government system and to the economy as a whole;
— Customs systems can be modernized to provide international transit facilities to make the country a land bridge for the region.

3.4. Threats

There are a variety of threats inherent in the current situation, including:

— Refusal of local authorities to allow customs to function under the sole control of the ACD will regress the functioning of the department;
— Interference of other ministries in the customs clearance process including transit operations leads to delays and harassment of traders;
— Deterioration in security conditions in the provinces and more particularly the borders will severely affect customs operations;
— Budgetary shortages leading to poor financing of the operational expenses of the ACD and inability to pay adequate compensation to customs staff can undermine customs reform and modernization efforts;
— Delays in recruitment and formation of a permanent customs cadre, with service and disciplinary rules, will impede the progress of reforms and hamper the emergence of the ACD as a professional body capable of delivering high quality customs services;
— Withdrawal of donor funding for infrastructure development will severely retard the growth of customs and cargo handling/storage services in the country.

4. REFORM PROGRAMME OBJECTIVES

The reform programme has been devised keeping in mind the strengths and weaknesses of the ACD, with the intention of reaching the overall goals of the plan. The programme lays down objectives which represent the strategic position that the ACD wants to attain within the plan period. Within the five year period, the Ministry of Finance will have the plan objectives outlined in the following discussion.

Technical advancement for more efficient collection of revenue:

- In order to collect customs duty efficiently to meet the long term fiscal targets fixed by the Ministry of Finance, all fair and transparent managerial steps will be adopted;
- Automation of all customs business processes so as to facilitate customs clearance within risk management parameters developed on a market segmentation approach;
- Automation of processes to develop a reporting system on revenue and trade data;
- Developing capacity to analyse data so as to monitor revenue collection, modify rates of duty so as to balance the need of the Government to raise funds with the need to facilitate trade;
- Fair and transparent mechanisms for settlement of disputes will be created and the capacity to work with the judicial system internalized by the ACD;
- Key performance indicators (KPIs) and milestones will be established to ensure that the strategic plan is implemented effectively;
- A central audit and inspection programme is established that is based upon risk assessment and ensures efficient realization of duties and harmonization of customs practices in different customs offices.

Trade facilitation measures:

- Establishment of a customs facility for international transit of goods, and to streamline procedures for warehousing;
- Developing the necessary legal and executive instruments to enable the setting up of regional opportunity zones and other such inward processing facilities.

Strengthening enforcement and compliance:

— A comprehensive review of the legal framework, customs instructions and standard operating procedures will be undertaken and suitable amendments made with a view to enhancing the capability of the ACD to strengthen its enforcement machinery;
— Laws relating to enforcement provisions will be reviewed in order to enable the enforcement machinery to perform better;
— Introduction of a reward/incentive scheme for encouraging good performers in all fields of customs operations — enforcement and others.

Customs–business partnership:

— Partnership formed with trade to spread awareness of laws and procedures, and encourage the maximum level of voluntary compliance with laws;
— Accelerated clearance procedures established for accredited clients (through market segmentation approach).

Interdepartment coordination:

— Inputs provided to Government for better tax policy formulation and development plans;
— Intelligence coordination mechanism with other departments and ministries established for suppression of narcotics trade, violation of intellectual property rights and other crimes against society.

Structure and human resources of the ACD:

— Constitution of customs as an autonomous authority with the capability to recruit staff, regulate their service conditions, maintain disciplinary control and supervise customs operations of all customs offices without interference from local authorities and other departments;
— Capacity building programmes that were prepared by consultants in the past will be employed for training staff of different categories.

Physical infrastructure:

— Major building infrastructure and equipment at the headquarters and in the provinces will be raised or restored to enable proper functioning of the ACD;
— Inland clearance terminals, warehouses and other facilities needed to facilitate trade will be built;

— Constitution of an autonomous body for customs clearance in terminals at inland areas or border posts under the Ministry of Finance that will be charged with the responsibility of raising cargo storage and handling centres, and operating terminal warehousing services.

5. PERFORMANCE EVALUATION UNDER THE FIVE YEAR PLAN

The broad indicator of achievement of the five year plan can be derived from ratios based on macro-activity values as shown below, using methodology developed by the World Bank or that used by other customs organizations. The ACD should set targets based on the anticipated evolution of trade, and realistic targets in terms of performance. These will then show in the matrix below (Table 1), which provides comparable values that can be checked against international benchmarks. A set of annual indicators of productivity and their progress from year to year will enable monitoring of performance under the five year plan.

At local level, clearance and operational performance can be assessed according to the pilot site methodology used by the World Bank. This is based on the measurement of sample data for time for release (or clearance) and levels of compliance. The data are aggregated into simple indicators of: (1) time to clear the border; (2) transit times; (3) time for clearance at inland customs houses; and (4) rates and results of controls.

6. REFORM PROGRAMME OVERVIEW

There are five foundation pillars to the reform programme which are planned for implementation over the next five years:

(a) Customs reform — law and procedures aimed at bringing efficiency in revenue collection and facilitating trade:
   (i) Automation;
   (ii) Legislation and procedures;
   (iii) Streamlined valuation process;
   (iv) Appeals and litigation (dispute resolution);
   (v) Transit corridors improvement;
   (vi) Warehousing;
   (vii) Inward processing and temporary imports.

TABLE 1. PARAMETERS FOR MEASURING ACHIEVEMENT

	2001	2002	2003	2004	2005	2006	2007	2008
Total customs revenue (US $ million)		64.99	77.16	137.59	105.89	121.73		
Total customs cost (US $ million)		0.56						
Total customs staff		1379	1100	1174	1876			
Total customs salaries (US $ million)					0.91			
Annual number of declarations		4530	100 000	352 749				
Import		4512		352 749				
Export		18						
Imports (US $ million)	1695.79	1271.07		2198.00				
Exports (US $ million)								
Total (US $ million)			87.33	2198.00				
Revenue collected/customs staff	47 128	70 145	117 198	56 445				
Total customs cost/revenue collected	0.86%	0.00%	0.00%	0.00%				
Salaries/revenue collected	0.00%	0.00%	0.00%	0.86%				

TABLE 1. PARAMETERS FOR MEASURING ACHIEVEMENT (cont.)

	2001	2002	2003	2004	2005	2006	2007	2008
Trade volume/staff (US $)			1 872 232	0				
Declarations/staff	3	91	300	0				
Economic cost per declaration	123.62							
Average monthly salary cost				40.61				
Average revenue per declaration	390.05							
Average value per declaration	6231.06							
Ratio (effective rate)	6.26%							

(b) Enforcement and voluntary compliance:
   (i) Risk management;
   (ii) Detecting offences;
   (iii) Anti-smuggling;
   (iv) Border operations.
(c) Organization change:
   (i) Placement of customs;
   (ii) HR policies;
   (iii) Career plan;
   (iv) Incentive bonus rewards;
   (v) Pensions;
   (vi) Ethics;
   (vii) Management of disciplinary cases;
   (viii) Capacity building and training;
   (ix) Funding of organizational costs.
(d) Interdepartment coordination and business partnership;
(e) Infrastructure and equipment.

7. PROJECT COMPONENTS OF REFORM PROGRAMME PART I: CUSTOMS REFORM — LAW AND PROCEDURES

Part A deals with projects that will aim at creating customs assessment and procedures on a par with international standards. This will involve review of the present laws and procedures to induce efficiency in revenue collection, facilitating them and reducing corruption.

AUTOMATION: Automation as the basis for customs reforms and trade facilitation. Modern customs practice is based on business practices supported by automation which is very different from manual processes.

The ASYCUDA software has been introduced for customs automation in the ACD. Initially, the declaration processing system and the transit processing system were introduced at the major customs houses by the team from ASYCUDA. This has already begun producing positive results on enhanced revenue collection and compliance. In the coming five years, the rollout of all modules of ASYCUDA is planned at all ACD customs stations coupled with the implementation of all its modules. The success of the automation in the future will be largely dependent on a number of factors such as the Government's and donors' commitment to the automation projects, business process re-engineering of customs operations, integration of the different processing system of ASYCUDA, availability of infrastructure, administrative and human resource support for ASYCUDA implementation and appropriate legislative changes for introduction of automation.

Currently, the EUROTRACE statistical and data collection application is being used just for data collection purposes. Customs clearance documents have not been entered into computers for vehicles in the past years. The process for the computerization of declarations manually processed with the EUROTRACE system will continue until ASYCUDA's modules generate similar reports from the data warehouse.

DEVELOPMENT AND STRENGTHENING OF THE NUCLEAR SECURITY STATUS IN LEBANON

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Abstract

Following international forums (IAEA, United Nations Security Council and the international community), Lebanon decided to undertake some essential steps to combat illicit trafficking and to strengthen the level of nuclear security within the country and at borders. For this issue, a number of treaties and resolutions have been signed and approved by the Lebanese Government.

1. INTRODUCTION

With the technical aid of the IAEA, the National Council for Scientific Research of Lebanon (CNRSL) founded the Lebanese Atomic Energy Commission (LAEC) in 1996 in order to promote both the peaceful use of atomic energy and to implement an infrastructure for radiation protection.

In 1998, the LAEC was assigned control of scrap export to ensure that it is free of either contamination or content of radioactive sources. In addition, this surveillance was also applied to imported iron used for building construction. The portable instruments used for radiation detection were moderately sensitive. An inventory on the number, activity, location, status, type and use of radioactive materials existing in Lebanon was established; they are mainly located in hospitals, industries and universities.

However, over the last two years, an increasing number of radioactive incidents have been encountered in scrap activities. In addition, there are growing efforts from the international community, through the IAEA and the United Nations Security Council, to combat illicit nuclear trafficking, as there is a major concern that nuclear and other radioactive material may fall into the hands of terrorists or criminals who could use it for malicious purposes.

For all these reasons, Lebanon decided to reinforce the level of nuclear security in the country and to join international efforts by signing a number of IAEA and United Nations treaties and resolutions. Several practical steps were undertaken and are still being pursued.

2. NUCLEAR SECURITY LEVEL IN LEBANON

2.1. Current status and the Nuclear Security and Emergency Department

The LAEC of the National Council for Scientific Research of Lebanon is considered to be the national regulatory authority dealing with radioactive sources. Beside this duty, it took charge of illicit nuclear trafficking and became a member of the IAEA Illicit Trafficking Database (ITDB) [1].

To more effectively follow the illicit nuclear trafficking dossier, the LAEC recently established the Nuclear Security and Emergency Department (NSED) which will follow incidents during the different processing steps, from discovery to storage and, finally, will report to the ITDB office.

At the same time, the NSED is in charge of establishing a sustainable programme of nuclear security. NSED duties include checking the physical protection of Lebanon's nuclear facilities (radiotherapy in hospitals, irradiation in research centres) as well as of radioactive sources, in cooperation with the different sections and departments of the LAEC. In addition, the secure and safe transport of radioactive materials within the country is also within the mandate of NSED.

To develop this new activity and to strengthen its capabilities in the domain, more sensitive detectors were purchased and the hiring of trained inspectors was increased and became a first priority for the LAEC. Detection and monitoring were done using handheld radiation detectors, namely Exploranium GR-135 and GR-110. In the case of an incident, the radioactively contaminated object or radioactive source is located, isolated and then safely transported to the LAEC for further investigations. This procedure is undertaken jointly by the Waste Management Section and the Environmental Radiation Monitoring Department using an Easy-spec gamma detector (NaI detector, 3×3), a Greatz X5 DE detector or a high purity germanium (HPGe) detector.

2.2. Incidents encountered

Since 2005, more than 40 incidents have been recorded during scrap export, mostly at the seaports of Beirut and Tripoli (Fig. 1).

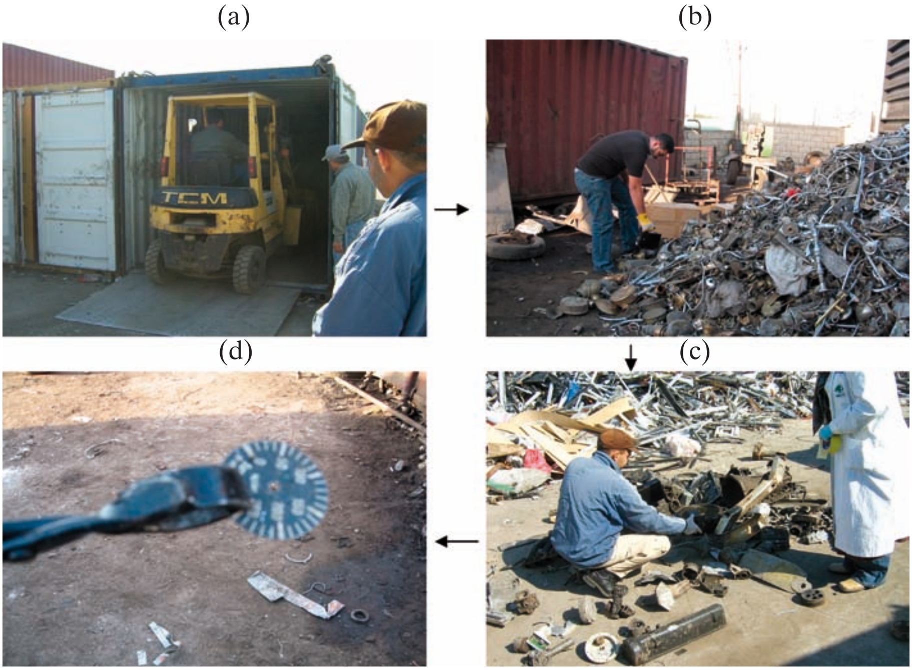

FIG. 1. Looking for a needle in a haystack: (a) and (b) during a routine scrap inspection, high reading counts of radioactivity are seen on the handheld detector; (c) searching the contents of a container; and (d) the radioactive source or the contaminated object is isolated and finally found.

These incidents are mainly considered to be unauthorized disposals of radioactively contaminated objects, radioactive materials or nuclear materials (Fig. 2). They can be summarized as follows:

— The radioactively contaminated scrap primarily involved ^{226}Ra where the measured dose rate was between 0.14 and 14 μSv/h on the surface of the located objects which included military scrap pieces, clocks, pipes, cylinders, metal discs and powders;

— Other incidents were related to sealed radioactive sources such as ^{90}Sr, ^{60}Co, ^{241}Am and ^{137}Cs. Figure 3 shows a jar shaped metal container shielding an encapsulated caesium source with an activity of 18 mCi. The shielding lead has a broken identification metal tag that has information about the source. It is clearly stated that it is a ^{137}Cs source of 30 mCi activity dated from 1984 and has the company name on the label. After further analysis and investigations, it was found that the source, intended to be exported as regular scrap, was used for radiometric density

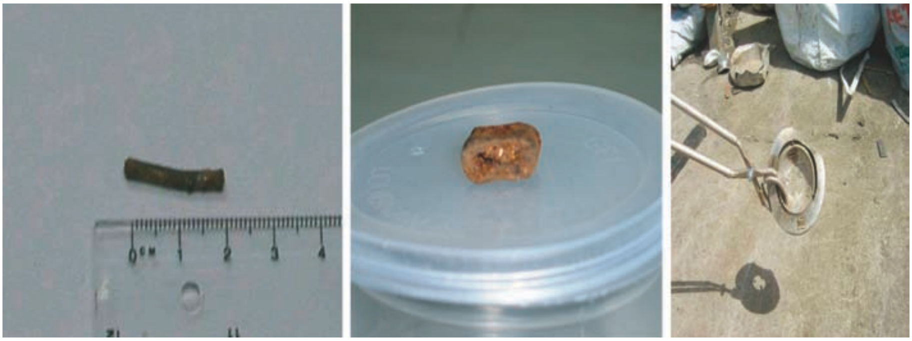

FIG. 2. Examples of orphan sources found in scrap (^{60}Co, ^{90}Sr, ^{226}Ra).

measurement in a local cement company. The necessary actions were carried out in order to ensure the security and safety of the source. Moreover, the company has pledged not to repeat this serious incident resulting from negligence;

— Finally, some other seizures were concerned with nuclear material such as depleted uranium or ^{232}Th.

Until now, most of the materials involved in the different incidents are of unknown origin, so they are temporarily being stored in a safe location at the LAEC, until the founding of a national storage facility.

FIG. 3. Lead shielding of a ^{137}Cs source, used for radiometric density measurement, found within regular scrap.

2.3. Perspectives

Due to national policy and international requirements, NSED/LAEC will enhance their capabilities for better radiation control of Lebanese borders and maritime ports. In this regard, a project, supported by the IAEA, will be set up in cooperation with Lebanese customs. It consists of the installation of a radiation portal monitor at the Masnaa checkpoint, to be followed in due course by another one at Beirut's port. In this way, more than 90% of the commercial exchange activities between Lebanon and other countries will be covered. The system will be connected directly to the LAEC for better assessment and control. LAEC inspectors will be permanently present at the site with a local laboratory for more advanced measurements. Furthermore, customs and LAEC staff will be equipped with portable detectors and will work in close cooperation.

However, there is a need for more effective actions that require collective and coordinated efforts at the regional and inter-regional levels, as well as working in close cooperation. Moreover, Lebanon requests more support from the international community to enhance and sustain its national programme on the development and strengthening of its nuclear security status.

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RADIATION CONTROL AND PREVENTION OF NUCLEAR AND ILLICIT RADIOACTIVE TRAFFICKING IN INDONESIA

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Abstract

The utilization of nuclear energy in medicine, industry and research has been widespread in Indonesia in various applications. Based on Nuclear Energy Act No. 10 of 1997, the Nuclear Energy Regulatory Agency is the regulatory body which has the function of regulating and controlling the utilization of nuclear, radioactive and radiation sources. Some regulations have been amended to harmonize with a number of IAEA publications, including the Basic Safety Standards and the Code of Conduct on the Safety and Security of Radioactive Sources. Indonesia has many seaports and airports as the ports of entry of radioactive sources, so the role of customs and port authorities is very important for preventing illicit trafficking of nuclear and radioactive sources. The paper addresses the control system of radioactive sources and radiation, provisions of import and export of radioactive sources, and specific issues to be solved to prevent illicit trafficking and to detect unauthorized movement of radioactive sources.

1. INTRODUCTION

The utilization of nuclear energy in medicine, industry and research has been widespread in Indonesia. The numbers of licensees has been increasing rapidly over the last two decades. There are almost 3000 hospitals and clinics, 20 of which have radiotherapy machines, and 450 industries using radioisotopes for industrial radiography, well logging, gauging and irradiation. There are also one multipurpose reactor (30 MW), one Triga Mark II (2000 kW), one Triga Mark II (100 kW), one fuel fabrication for a research reactor and one waste management facility. Based on Nuclear Energy Act No. 10 [1], the Nuclear Energy Regulatory Agency (BAPETEN) is the regulatory body which has the function of regulating and controlling the utilization of nuclear, radioactive and radiation sources. The control of the utilization of radiation sources is aimed at ensuring welfare, security and peace; the safety and health of radiation workers and the public; environment protection; preventing diversion of the purpose of nuclear materials utilization; and to develop a safety culture. Some government regulations have been established to implement the act. A new government regulation which amended the government regulation on safety and health against ionizing radiation includes provisions for nuclear and radioactive sources security [2, 3]. This regulation has been harmonized with a number of IAEA publications [4, 5, 6], including the Code of Conduct on the Safety and Security of Radioactive Sources in many parts [7]. The new regulation on licensing will soon be issued to amend Government Regulation No. 64 [8, 9]. To communicate the regulations to the stakeholders and the public, BAPETEN has held seminars and undetaken outreach activities. Indonesia has many seaports and airports as the ports of entry of radioactive sources, so the role of customs and port authorities is very important to prevent illicit trafficking of nuclear and radioactive sources.

2. CONTROL OF RADIOACTIVE SOURCES AND RADIATION

Based on Ref. [1], BAPETEN controls all the users of radioactive sources and radiation through drafting of regulations, issuance of licences and inspection. BAPETEN currently has around 450 staff of which 50 are senior inspectors. There are some government regulations and chairman decrees which must be complied with for the utilization of radioactive and radiation sources. The regulations have provisions for authorization for receipt, possession, use, transport, import, export and disposal of radioactive sources. To obtain a licence, the user must meet certain requirements which are stipulated in Ref. [8], which is now being amended.

Importers and exporters of radioactive sources must meet requirements, such as the availability of a radiation protection officer, a calibrated survey meter, a personnel monitor and temporary storage. In addition, the importer must submit the contract for re-shipment of radioactive sources to the country of origin. The importer must also submit the import documents to be verified and approved by BAPETEN for customs clearance. This system has been well established at the Port of Tanjung Priok and at Cengkareng Airport in Jakarta by good coordination with customs.

3. SEALED SOURCES USED IN INDONESIA

The sealed sources used in Indonesia are listed in Table 1.

TABLE 1. SEALED SOURCES USED IN INDONESIA

Devices	Sources	No. of licensees	No. of sources
Gamma radiography	^{192}Ir, ^{60}Co	52	273
Nucleonic gauges	^{137}Cs, ^{60}Co, ^{241}Am, ^{90}Sr, ^{241}Am-Be, ^{147}Pm, ^{244}Cm	151	2046
Gamma irradiator	^{60}Co	2	3
Gamma chambers	^{60}Co	1	1
Gamma teletherapy	^{60}Co	14	19
Gamma brachytherapy	^{192}Ir , ^{137}Cs	8	54

4. REQUIREMENTS FOR IMPORT AND EXPORT OF RADIOACTIVE SOURCES

4.1. Import of radioactive sources

The following requirements govern the import of radioactive sources:

(a) Any legal institution or person who imports radioactive sources shall obtain a licence from BAPETEN;
(b) A licence can be obtained by submitting an application to BAPETEN with a document of import of radioactive sources as defined by other relevant regulation;
(c) Importers of Category I and II radioactive sources shall submit to BAPETEN a copy of the document which states that the exporter has been authorized by the regulatory authority of the exporting State;
(d) The submitted copy of the document shall contain at least the following information:
  (i) Name of the exporter;
  (ii) Exporter location and legal address or principal place of business;
  (iii) Radionuclide and radioactivity;
  (iv) Export authorization expiration date;
(e) Before Category I and II radioactive sources are imported, the importer shall provide to BAPETEN:
  (i) Confirmation that the shipment by the exporter complies with national and international regulations related to transport;
  (ii) A copy of the approval letter of export from the exporting State at least seven days before the scheduled import.

4.2. Export of radioactive sources

The following requirements govern the export of radioactive sources:

(a) Any legal institution or person who exports radioactive sources shall obtain a licence from BAPETEN;
(b) A licence can be obtained by submitting an application to BAPETEN with a document of export of radioactive sources as defined by other relevant regulation;
(c) Exporters of Category I and II radioactive sources shall submit to BAPETEN a copy of the document which states that the recipient has been authorized by the regulatory authority of the importing State to receive and possess the sources;
(d) The submitted copy of the document shall contain at least the following information:
  (i) Name of the recipient;
  (ii) Recipient location and legal address or principal place of business;
  (iii) Radionuclide and radioactivity;
  (iv) Recipient authorization expiration date;
(e) The exporter shall notify the importing State at least seven days in advance of shipment with the following information in writing:
  (i) The estimated date of export;
  (ii) Exporting facility;
  (iii) Recipient;
  (iv) Radionuclides and activity;
  (v) Aggregate activity level;
  (vi) The number of radioactive sources and, if available, their unique identifiers;
(f) The exporter shall notify BAPETEN in advance of each shipment of radioactive sources that the shipment complies with Ref. [10] and the other national and international regulations related to transportation. Each export and import of a Category I and II source shall be approved by BAPETEN.
(g) A copy of the notification document has to be submitted to BAPETEN at least seven days in advance of shipment of radioactive sources.

5. ILLICIT TRAFFICKING AND ITS PREVENTION

Illegal imports of radioactive sources were reported between 1997 and 2003; ^{137}Cs was imported 28 times by one company through some ports and seaports outside Jakarta. Five of the ^{137}Cs imports have been licensed and 23 were re-exported to the country of origin in February 2007. To prevent illicit trafficking, it is very important to increase awareness among the concerned officials, so BAPETEN will strengthen the coordination and cooperation with relevant authorities, such as customs, the police, the port authorities, Department of Transportation, etc. Many seminars as well as internal and external meetings have been held by BAPETEN to disseminate the regulations to all stakeholders and the public, and to promote awareness regarding the safety and security of radioactive sources. BAPETEN plans to train the staff of customs, port authorities and other parties which are involved in the import and export of radioactive sources.

Customs has installed several gamma scanners in some seaports. Some new scanners will be installed at big seaports on several islands. This is very important because Indonesia has so many seaports as entry points for radioactive source imports. Important seaports and airports used as entry points are located in Jakarta, Batam, Balikpapan, Medan, Surabaya, Makassar, Pekanbaru and Palembang. In those regions, there are many applications of Category I and II radioactive sources, so the establishment of good control and prevention of illicit trafficking in those areas has been prioritized. Transboundary trade and movements of radioactive sources have become specific issues to be discussed together with neighbouring countries.

The problems faced by BAPETEN and relevant authorities to prevent illicit trafficking of nuclear and radioactive sources are a lack of trained personnel and instruments, such as portal monitors and survey meters at seaports and airports.

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[3] Government Regulation No. 33, 2007, on the Ionizing Radiation Safety and Radioactive Sources Security, BAPETEN, Jakarta.

[4] FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, INTERNATIONAL ATOMIC ENERGY AGENCY, INTERNATIONAL LABOUR ORGANISATION, OECD NUCLEAR ENERGY AGENCY, PAN AMERICAN HEALTH ORGANIZATION, WORLD HEALTH ORGANIZATION, International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources, Safety Series No. 115, IAEA, Vienna (1996).

[5] INTERNATIONAL ATOMIC ENERGY AGENCY, Categorization of Radioactive Sources, IAEA-TECDOC-1344, IAEA, Vienna (2003).
[6] INTERNATIONAL ATOMIC ENERGY AGENCY, Security of Radioactive Sources — Interim Guidance for Comment, IAEA-TECDOC-1355, IAEA, Vienna (2003).
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[8] Government Regulation No. 64 Year 2000 on Licensing of the Utilization of Nuclear Energy, BAPETEN, Jakarta.
[9] Chairman Decree No. 7 Year 2007 on Security of Radioactive Sources, BAPETEN, Jakarta.
[10] Government Regulation No. 26 on the Safe Transport of Radioactive Material, BAPETEN, Jakarta.

DISCUSSION

SESSION 6: International Initiatives and National Efforts to Establish Capabilities — III

B. McNABB (United States of America): Was there any decrease in criminal activity at border checkpoints as a result of increased border personnel?

A. ČIŽMEK (Croatia): We have not noticed anything yet. Maybe it is too soon. Also, we need to be better connected with police at other borders because sometimes smugglers, when they notice that control has improved at one crossing point, choose a less well controlled one. We are planning the installation of 14 more portal monitors or mobile devices, which will extend the area of Croatia covered.

A. AZHAR (Indonesia): Who provided and prepared the training material for the customs officers?

B.M. MOMCILOVIC (Serbia): We did it in cooperation with the Institute of Physics, Belgrade, because of budget requirements.

B. STICKNEY (United States of America): Is there sufficient cooperation between the IAEA, the European Commission's European Agency for Reconstruction (EAR) and customs authorities in the recipient countries on constructing/renovating border crossing points? A number of new border crossing points have been built in the Balkans but none of them seem to have included the installation of portal monitors in their original plans. Why is that?

A. ČIŽMEK (Croatia): Croatia has 189 border crossings. The reason we do not have more portal monitors is because they are so expensive.

B. STICKNEY (United States of America): How much does it cost approximately to install a portal monitor?

A. ČIŽMEK (Croatia): I do not know. The Ministry of Finance takes care of the money.

B.M. MOMCILOVIC (Serbia): I think it is US $150 000. Concerning regional cooperation, this is a unique idea for our region, initiated without any external help from the IAEA or others. As to the number of portals, we applied for eight to be financed through pre-accession funds (IPA 2008). If we get them (with the existing one, that makes nine portals), we can — through regional cooperation for monitoring road and rail — reach an agreement with all neighbouring countries to cover the whole territory much better and more cost effectively.

A. ČIŽMEK (Croatia): I did not realize you meant the cost of just the monitor, because that is not the whole cost. The contingent costs were what I was not sure about. Another point about coordination: generally, although cooperation between Croatia and its neighbours is good, we did not know when we received the donation from the IAEA that Slovenia was about to install portal monitors donated by the USA on the same mountain pass. That should not happen. Donors as well as recipients need to coordinate their activities.

B. STICKNEY (United States of America): A portal monitor generally costs US $100 000 or more. When a new crossing point is constructed, depending on the size, it may cost a few million euros. I feel there is not an appropriate dialogue between the IAEA, the EAR and the recipient countries. Perhaps for a little more money, we could get a lot more protection. We saw the same thing in Montenegro when USAID assisted in building seven border crossing points. Putting in portal monitors then where required would have been a relatively small additional expense. There needs to be more dialogue on key issues between the main stakeholders.

A. ČIŽMEK (Croatia): Even when you have portal monitors, you need focused training and technical support by radiation experts.

C. STOIBER (United States of America): I have a question for the speakers. If this conference were to make one important recommendation that could help you to become more effective in combating illicit trafficking, what would it be?

B.M. MOMCILOVIC (Serbia): Coordinate donors to help countries in need.

V. ROMERO DE GONZÁLEZ (Paraguay): Paraguay's customs service bought a mobile scanner with its own funds — a great effort with positive consequences because now — with the help of the IAEA — we can better protect our frontiers. It would be most helpful to improve our capability with more detectors.

M.D.A. TSHIASHALA (Democratic Republic of the Congo): My country has requested assistance from the IAEA in obtaining equipment to control border trafficking in radioactive minerals and material. We shall also request assistance in solving problems related to illicit trafficking.

A. ČIŽMEK (Croatia): For me, the benefit from this conference will be learning from the experience of others. Also, we get an overview of improvements in technology and see new products. It is good to have all this shown to us in one place. In addition, it would be good to be able to get more donations to support our border control.

SESSION 6: International Initiatives and National Efforts to Establish Capabilities — IV

M. CAMPBELL (United Kingdom): The USA continues to address this issue at both the federal and state levels. Has this given rise to any difficulties in coordination?

P. HOLAHAN (United States of America): The Federal Government works with states on developing regulations. Although it has relinquished authority to the states, their regulations have to be compatible with federal regulations. We review the states' regulatory processes periodically — through an integrated materials programme evaluation process — for licensing, inspection and enforcement to ensure that they are adequate and compatible with the federal programme.

C. STOIBER (United States of America): What recommendations should the conference make to enhance efforts to combat illicit trafficking?

J.I. PRADAS-POVEDA (International Science and Technology Centre): To face the global challenge, international cooperation is critical. Efforts need to be integrated and involved agencies and stakeholders should pool their resources.

P. HOLAHAN (United States of America): We believe that the ITDB is a very useful means of sharing information but that it can be improved. We are willing to work with the IAEA to ensure that it is useful to all parties.

O. CROMBOON (European Commission): Although coordination of international efforts has improved, there is room for further improvement for the future.

A.S. SARHAL (Afghanistan): The problems of coordination in Afghanistan were highlighted in my paper. Please note that we lack all facilities and trained staff. I shall return to my country, having learned much from this conference, with many proposals to our Government for improvement.

M. ROUMIÉ (Lebanon): We are making good progress thanks to IAEA advice and assistance in acquiring some necessary nuclear security equipment. As we are in a transition stage, we would like this to continue.

A. AZHAR (Indonesia): My country needs assistance from the IAEA in training customs officers and port authorities, and in installing gamma scanners and portal monitors at seaports and airports.

F. AL-SHARQAWI (Kuwait): With IAEA assistance, we need to improve regional cooperation.

NEW TECHNOLOGIES

(Session 7)

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IAEA-CN-154/059

THE EVALUATION OF RADIATION INSTRUMENTATION USED FOR THE DETECTION OF ILLICIT TRAFFICKING OF RADIOACTIVE MATERIAL

According to the standards of the American National Standards Institute and the International Electrotechnical Commission

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Abstract

During the last quarter of 2002, an effort was started to develop performance requirements for radiation instrumentation used for the detection of illicit trafficking of radioactive material. Coordinated by the US National Institute of Science and Technology, a team was formed to establish writing committees for the development of these requirements as American National Standards Institute (ANSI) standards. The core of the new area was developed as ANSI N42, Homeland Security Instruments. A series of standards were developed followed by testing and evaluation (T&E) protocols that would be used for specific testing. Four US national laboratories provided T&E support, and work commenced to test instruments provided by manufacturers at no cost. During this time, discussions began regarding the formation of a new work group within the International Electrotechnical Commission (IEC). This new work group would be located within TC 45/SC 45B which addresses radiation protection instrumentation. The new work group, B15, also began developing international standards to address the same instrument types. Since 2006, three IEC standards concerning the detection of illicit trafficking of radioactive material were published and four more are now in development. A summary of the most important characteristics of these IEC standards is presented.

1. STANDARDS ACTIVITIES

After the terrorist attacks of 11 September 2001, a greater need arose for radiation instruments that can be used by non-radiation professionals for the detection of radioactive material that could be used for illicit purposes. Although some of this equipment was already available, there were no published, consensus based performance requirements available to use as tools for the analysis and qualification of these instrument types. Consensus based, publicly available standards can help ensure consistency across the user community and increase the reliability of the instruments to perform as expected. Consistency enables a comparison of measurements and provides the assurance that a device at least meets a certain level of reliability when operated under expected environmental conditions.

A critical item that makes the standards for this type of instrument different from those that might be used to address radiation protection type instruments involves the control of information. Information obtained that may indicate a susceptibility or functional limitation will need to be controlled to some extent. This means that some test or qualification results will require control to the extent that the results cannot be released to the general public.

In the USA, one of the first actions was to establish a homeland security specific standards group within the existing framework of the American National Standards Institute (ANSI) radiation protection instrumentation organization. This specific group became known as ANSI N42, HSI — Homeland Security Instrumentation. Somewhat simultaneously, a prioritized list of standards was established based on the needs of the user and the monitoring community. This list consisted of standards for personal radiation detectors (PRDs) or ‘radiation pagers’ as they are more commonly known. Other standards included those associated with portable survey instruments, radionuclide identifier devices (RIDs), and non-spectroscopic portal monitors. To develop the first four standards, writing committees were formed. Each writing committee was chaired by a recognized expert for that specific device with members from the user community, manufacturers and US national laboratories.

A basic format developed over time that included general requirements and test procedures. General requirements usually included electrical (battery or line), dimensional and weight, alarm functionality, speed control or measurement for portal monitors, general design, radiological functionality (response and/or identification) and documentation. Testing was established to ensure that the stated requirements were met. Verification testing included radiological, environmental, mechanical and electromagnetic. Many of the non-radiological requirements and test protocols are based on existing US or international standards. For the USA, referenced standards included those from ANSI and the US military. The international standards included many references from the International Electrotechnical Commission (IEC) with most relating to electromagnetic compatibility and environmental conditions.

Efforts within the international community were related to activities associated with the IAEA and the needs of its Member States. The publication technique for relevant standards for this application is addressed through the IEC for instrumentation requirements. The initial effort was to establish a standard for portal monitors used for the detection of illicit trafficking of radioactive material at national and international borders. This effort fell within working group (WG) B9 of subcommittee (SC) 45B of technical committee (TC) 45. TC 45 consists of experts that address requirements associated with nuclear instrumentation. TC 45 has two subcommittees, one for power plant control related equipment (SC 45A) and the other for radiation protection instrumentation (SC 45B). The best committee for this effort was SC 45B. The portal monitor standard was jointly led by experts from the USA and the Russian Federation. During the development of the portal monitor standard, decisions were made to establish a specific working group to address radiation detection instruments used for security applications. The working group (WG) is B15 and was titled Illicit Trafficking Control Instrumentation using Spectrometry, Personal Electronic Dosimeter and Portable Dose Rate Instrumentation. The group is being led by the USA with members from Austria, China, France, Germany, the United Kingdom, Italy, the Russian Federation, Sweden, Ukraine and the USA with observers from the IAEA.

2. STATUS

2.1. ANSI standards

Following the publication of the first four ANSI standards, a number of instrument models were tested using non-published testing and evaluation (T&E) protocols developed from each specific standard. The T&E process will be discussed later in this paper. The first four standards are ANSI N42.32, “Performance criteria for alarming personal radiation detectors for homeland security”; ANSI N42.33, “Portable radiation detection instrumentation for homeland security”; ANSI N42.34, “Performance criteria for hand-held instruments for the detection and identification of radionuclides”; and ANSI N42.35, “American national standard for evaluation and performance of radiation detection portal monitors”. These standards were published in 2003 and were later revised based on the results of the T&E efforts. The revisions were published in early 2007. Other standards that have been published include 42.37, “Training requirements for homeland security responders using radiation detection instruments”; 42.38, “Performance criteria for spectroscopy-based portal monitors used for homeland security”; 42.42, “Data format standard for radiation detectors used for homeland security”; and 42.43, “Performance criteria for mobile and transportable radiation monitors used for homeland security”.

Standards that are being prepared for publication, meaning that they are in the final stages of development, are 42.41, “Standard for evaluation and performance of neutron interrogation systems for detection of contraband of concern in homeland security”; and 42.48, “Performance requirements for spectroscopic personal radiation detectors (SPRDs) for homeland security”.

ANSI standards that are under development are 42.44, “Performance and evaluation of checkpoint cabinet X-ray imaging security-screening systems”; 42.45, “Evaluating the image quality of X-ray computed tomography (CT) security-screening systems”; 42.46, “Measuring the performance of imaging X-ray and gamma-ray systems for cargo and vehicle security systems”; and 42.47, “Measuring the imaging performance of X-ray and gamma-ray systems for security screening of humans”.

2.2. IEC standards

IEC efforts mostly involve activities within WG B15 of SC 45B. IEC 62327, “Hand-held instruments for the detection and identification of radionuclides and additionally for the indication of ambient dose-equivalent rate from photon radiation” was published in early 2006. IEC 62401, “Alarming personal radiation devices (PRD) for detection of illicit trafficking of radioactive material” being led by France was published in July 2007.

The IEC standard that will address spectroscopic portal monitors, IEC 62484, is currently at the committee draft (CD) stage and is being led by the USA. Other standards being developed include IEC 62534, “Highly sensitive hand-held instruments for neutron detection of radioactive material” being led by the USA; IEC 62533, “Highly sensitive hand-held instruments for photon detection of radioactive material” led by France (both at CD stage); and IEC 62523, “Cargo/vehicle radiographic inspection systems” that is in the early stages of development and is being led by China. Several tens of experts participate in the technical discussions and the last interim meeting of WG B15 occurred at the IAEA in June 2007.

Within WG B9 of SC 45B, IEC 62463, “X-ray systems for personnel security screening” is currently at the CD stage and is being led by the United Kingdom. Ten international experts attended the last interim meeting of WG

B9 held in London in June 2007. WG B9 was also responsible for the production of IEC 62244, “Installed radiation monitors for the detection of radioactive and special nuclear materials at national borders” which was published in 2006.

Before publication, each project is submitted at three different stages to the 20 participating national committees for a vote with a qualified majority.

The European Committee for Electrotechnical Standardization (CENELEC) has an agreement with IEC to consider newly published IEC standards for adoption as European standards. The CENELEC technical committee CLC/TC45 (formerly known as BTTF 111-3), which is a mirror of IEC/SC 45B, has recently decided to start such a procedure for IEC 62327 and IEC 62244.

A summary of the most important characteristics of IEC 62327, IEC 62244 and IEC 62401 is presented in Table 1.

Ongoing issues for both international and US standards include the selection of radionuclides for identification type instruments, radioactivity levels and concerns over the possibility that instruments will be designed to pass the test only (‘bookends’). The selection of radionuclides becomes important when working with instruments that provide identification capabilities. These instruments typically use a library of radionuclides to enable identification. The list of radionuclides that can or should be identified during testing is not endless (Table 2). A list was established early on during the standards efforts. This list has caused concern from instrument developers concerned over the likelihood of actually seeing some of the sources during use. That concern shows the difference between instruments used for the detection of illicit radioactive material and those used for radiation protection. With the potential use of radionuclides for radiological dispersal devices, the list can be endless. In addition, instruments used for these security applications are, as stated previously, used by non-professionals. That means indicated results must be unambiguous and obtained with high confidence. These factors alone make it very difficult to develop and manufacture acceptable instrumentation.

Radioactivity levels are also concerning, primarily over the possible release of information that could indicate the level of sensitivity of a system. How much radioactive material could be detected by the device? This information could be considered sensitive to some organizations and has to be controlled appropriately. In the standard where activity values are given, a basic caveat is used, stating that the values chosen are for test only and not as an indicator of sensitivity level.

Radioactivity levels and radionuclide lists can establish ‘bookends’. Bookends may establish design barriers that may be taken advantage of by adversaries or those that are trying to get around a detection system. Should

TABLE 1. SUMMARY OF THE MOST IMPORTANT CHARACTERISTICS OF IEC 62327, IEC 62244 AND IEC 62401

	IEC 62327	IEC 62244	IEC 62401
Size	Handheld	Installed	Pocket sized, carried on the body
Main purpose	Detection and identification of radionuclides	Detection of radioactive and special nuclear materials at borders	Detection of the presence and general magnitude of radiation
Additional purpose details	Indication of the ambient dose equivalent rate from photon radiation	Monitoring vehicles, cargo containers, people or packages	Self-reading, alarming PRDs
Photon detection	Identification of more than 20 single or mixed, unshielded or shielded radionuclides producing 0.5 μSv/h above gamma background. At least 90% of recognition trials shall be successful	Trigger alarm when the measured count rate is greater than the alarm setting using ^{241}Am, ^{137}Cs and ^{60}Co sources. Probability of detecting this alarm condition ≥90%	Trigger a gamma alarm within 2 s when the air kerma rate is increased by 0.5 μGy/h using ^{241}Am, ^{137}Cs and ^{60}Co sources
Neutron detection	Mandatory. Neutron alarm within 10 s when 0.01 μg unmoderated ^{252}Cf source is at 25 cm	Mandatory. Neutron alarm whenever neutron count rate is greater than the alarm setting. Using unmoderated ^{252}Cf source with fluence rate of 0.04 n cm^2 s^{-1}	Optional. Neutron alarm within 3 s when 0.01 μg unmoderated ^{252}Cf source is at 25 cm. The instrument is tested on a phantom
Temperature and relative humidity	The instrument shall be fully functional at temperatures from –20 to 50°C (ramp and shock change) and over the range of humidity up to 93% at 35°C	From –25 to 40°C, and for relative humidity up to 93% at 40°C, response within 15% versus response at 20°C. From 40 to 55°C, response within 50% versus response at 20°C	From –20 to 50°C (ramp and shock change) and for relative humidity from 40 to 93% at 35°C. No change by more than ±30% or one unit of indication, whichever is greater
Other requirement	Mechanical, false alarm, overload, power supply, vibration, electrical and electromagnetic, documentation, etc.		
Publication	February 2006		July 2007

TABLE 2. RADIONUCLIDES SELECTION FROM ANSI N42.38 AND IEC 62484 CD[a, b]

ANSI N42.38[c]	• Special nuclear materials (SNM): Uranium (used to indicate ^{233}U, ^{235}U), ^{237}Np, Pu. • Medical radionuclides: ^{18}F, ^{67}Ga, ^{51}Cr, ^{75}Se, ^{89}Sr, ^{99}Mo, ^{99}mTc, ^{103}Pd, ^{111}In, Iodine (^{123}I, ^{125}I, ^{131}I), ^{153}Sm, ^{201}Tl, ^{133}Xe. • Naturally occurring radioactive material (NORM): ^{40}K, ^{226}Ra, ^{232}Th and daughters; ^{238}U and daughters. • Industrial radionuclides: ^{57}Co, ^{60}Co, ^{133}Ba, ^{137}Cs, ^{192}Ir, ^{204}Tl, ^{226}Ra, ^{241}Am.
IEC 62484 CD	• Special nuclear materials (SNM): Uranium (used to indicate ^{233}U, ^{235}U), ^{237}Np, Pu. • Medical radionuclides: ^{18}F, ^{67}Ga, ^{51}Cr, ^{89}Sr, ^{99}Mo, ^{99}mTc, ^{103}Pd, ^{111}In, Iodine (^{123}I, ^{125}I, ^{131}I), ^{153}Sm, ^{201}Tl, ^{133}Xe. • Naturally occurring radioactive material (NORM): ^{40}K, ^{226}Ra, ^{232}Th and daughters; ^{238}U and daughters. • Industrial radionuclides: ^{57}Co, ^{60}Co, ^{75}Se, ^{133}Ba, ^{137}Cs, ^{192}Ir, ^{204}Tl, ^{226}Ra, ^{241}Am.

[a] The IAEA Safety Standards Series No. RS-G-1.9 (see footnote b) contains a list of radionuclides and categories. This is an informative list and should not be considered as all inclusive.

[b] INTERNATIONAL ATOMIC ENERGY AGENCY, Categorization of Radioactive Sources, IAEA Safety Standards Series No. RS-G-1.9, IAEA, Vienna (2005).

[c] For this standard, HEU has an enrichment that is at least 93.5% ^{235}U, DU at 0.2% ^{235}U and Un at 0.7%. RGPu contains 24% ^{240}Pu and WGPu 6% ^{240}Pu.

the radionuclide list used for testing include more or less radionuclides? Should it be limited to those radionuclides with actual or biological half-lives that make them more of a hazard? What would be the consequences of a release of even a short half-life radionuclide? For radioactivity levels, should the levels be lowered as the devices improve enabling increased sensitivity? What is a tolerable alarm level?

3. TESTING AND EVALUATION

This paper will discuss efforts associated with the standards mentioned previously. There are other testing efforts ongoing in the USA which will not be discussed here. There are also efforts going on at the IAEA to support IAEA and Member States' needs that will also not be discussed.

Once the initial four ANSI standards were nearing completion, separate groups were formed to establish T&E protocols. Each standard had an associated T&E which had limited publication. The T&E protocols were used to test a selection of instruments provided by individual manufacturers at no cost. The first round of tests was performed at four US national laboratories: Lawrence Livermore (LLNL), Los Alamos (LANL), Oak Ridge (ORNL) and Pacific Northwest (PNNL). The entire effort was coordinated by the US National Institute of Standards and Technology (NIST). Each national laboratory was selected primarily based on the leadership of the ANSI standard. Portable instruments were tested primarily at LLNL with PNNL and ORNL. PRDs were tested at PNNL with ORNL. LANL with ORNL tested portal monitors, and ORNL tested the provided RIDs. For Round 1, a total of more than 190 instruments were tested with 28 manufacturers involved. There were 20 PRD models, 25 portable surveyor instruments, 8 models of RIDs and 15 portal monitors. Test results were provided to NIST for consolidation and report generation. Eventually, the results were provided to individual manufacturers and the user community through an access controlled web page.

A second round was performed using the same basis as the first round. For the second round, most of the instrument types were tested at ORNL through the Environmental Effects Laboratory[1] with PNNL testing a few models. Twelve instrument manufacturers provided a total of 117 instruments. These included 16 PRD models, 11 portable instrument models, 8 RIDs and portal monitor models.

Test results from the second round indicated that improvements were being made in the general reliability and capabilities of instruments provided for testing. Round 1 testing showed that some instrument types were not necessarily prepared for use in the field. This was expected due to the lack of established performance requirements. Once the performance requirements were established, the manufacturing community who shared in their development could design their instruments according to an established set of performance requirements. Changes could be as simple as ensuring that sealing techniques to keep moisture out of the instrument were improved. Other changes may be more extraneous involving the selection and set-up of radiation detector components.

4. CONCLUSION

This document presented an overview of the efforts taking place with the goal of decreasing the possibility of the successful transport and use of illicit

[1] http://public.ornl.gov/estd/ACTS/

radioactive material. These efforts involve technical and professional persons from many different countries who work at manufacturing firms, national laboratories and test facilities. Information obtained from routine, standards based testing has enabled the improvement of radiation detection instrumentation. With these efforts, radiation detection instruments provided to the user community including border guards, customs officials and security personnel, are becoming more reliable and easier to use.

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IAEA COORDINATED RESEARCH PROJECT ON THE IMPROVEMENT OF TECHNICAL MEASURES TO DETECT AND RESPOND TO ILLICIT TRAFFICKING OF NUCLEAR AND RADIOACTIVE MATERIALS

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Abstract

Equipment to detect illicit trafficking of nuclear and other radioactive materials at borders and within a country has its own specific requirements and is very different from that used in other radiation monitoring cases. Automated and manual measurements need to be done in the field, often outdoors, at land or sea border crossing points or at airports. There should be a minimal impact on the free flow of goods and passengers, thus requiring that the measurement time be short. The design needs to be taken into account as the users of the equipment are not experts in radiation detection; thus, the results of the assessment should be easy to interpret. The IAEA coordinated research project on the Improvement of Technical Measures to Detect and Respond to Illicit Trafficking of Nuclear and Radioactive Materials was undertaken between 2003 and 2006 to address technical difficulties in these areas, to establish a forum between experts from various national and international institutions and final users of the equipment, and to form a consensus regarding the most important technical requirements for border monitoring equipment. The paper summarizes the results of three years of research, carried out under the framework of the coordinated research project mentioned. The main goal of the paper is to give an overview of the scope of work performed and to provide guidance through the topics addressed by the project rather than to present the technical details and achievements. The large number of references provided will guide interested readers to the specific subject and relevant paper.

1. INTRODUCTION

Research activities supported by the IAEA within the framework of coordinated research projects (CRPs) are designed to encourage the acquisition and dissemination of new knowledge, technologies and experience in safe, secure and peaceful uses of nuclear energy. As a rule, a CRP is a topical collection of 15–20 research contracts and agreements concluded between the IAEA and research institutes in Member States. Research contracts are awarded with the financial support of 10–20% of the total contract cost. A CRP is usually planned for three years, and at the end of each year it is expected that a research coordination meeting is held. At these meetings, research contracts and agreement holders coordinate their research activities with the IAEA, report about the results achieved and develop plans for the next year of the CRP. After completing the project, results of the individual agreements and contracts are published, and made available to the Member States.

2. SPECIFIC GOALS AND OBJECTIVES OF THE PROJECT

In 2003, shortly after the CRP commenced, it had already been demonstrated that the sensitivity of portal monitoring systems had become adequate, in particular after a series of national and international tests. However, a new problem had become obvious, which was troublesome to the users. The sensitive detection systems routinely picked up a considerable number of radiation alarms, which were of no significance to illicit trafficking but nevertheless required a response. They were caused either by medical isotopes in individuals or naturally occurring radioactive material (NORM) [1] in transported goods. Without effective tools in the hands of the responsible parties to quickly categorize the isotope, which had caused the alarm, the concept of border monitoring would not work.

The Illicit Trafficking Radiation Detection Assessment Program (ITRAP) [2] had, however, shown that none of the commercially available radionuclide identification devices (RIDs) could pass [3]. Gamma spectrometry and isotope identification using handheld gamma spectrometers or even automated spectrometric systems appeared to be the way to solve this dilemma.

While gamma spectrometry under laboratory conditions was already a mature technology in 2003, this was not the case for small, manually operated, handheld gamma spectrometers. Early instruments were plagued by instabilities and non-linearities of the energy scale, leading to failures in the identification of isotopes. The identification software was struggling with the low statistics of the gamma spectra taken with short measurement time, with low resolution of the scintillation detectors used and small gamma peaks against a high background of scattered gammas. Therefore, agreements and contracts to support the improvement of this important equipment class became a focus of the CRP.

Furthermore, the slow throughput, two step detection/categorization response bothered users who wanted a combination of alarm and immediate categorization. This was particularly needed in cases where frequent innocent or nuisance alarms caused unnecessary delay and disturbance of the public. Common examples include the highly visible response to the detection of a medical isotope in a person at an airport, or the high frequency of alarms at border crossing points caused by trucks transporting NORM. In addition, the ease of use of the instruments was often quite poor, resulting in the frustration of users at remote border crossings, etc., who were experts in other fields but not experts in radiation measurements.

Detection and characterization of shielded nuclear and other radioactive material, including verification of legal shipment, had to be addressed by the CRP because of the highest priority of the former and high number of the latter at the border.

3. COORDINATED RESEARCH PROJECT RESULTS

Under the CRP, significant scientific and technical contributions to the improvement of technical measures for nuclear security applications were made by 26 research groups and invited experts from 18 Member States to address the problems described previously.

Addressing the problems specified above, the CRP contracts were shaped around the following six broad areas:

— Standardization of border monitoring equipment;
— Improvement of RIDs;
— New technologies for nuclear security application;
— Development of new instrumentation;
— Detection of shielded special nuclear material and other radioactive material;
— Verification of legal shipment of radioactive material.

The most essential results of the CRP are summarized in the following section.

3.1. Standardization of border monitoring equipment

The annual research coordination meetings were used to develop a set of technical specifications for border monitoring instruments, discussing and agreeing them with a group of users and developers, including experts of the IEC and ANSI standards committees, and other standards drafting groups.

Procedures of various national and international standards (ANSI, IEC, ISO, GOST, RADTAP) for type test and performance monitoring of fixed radiation portal monitors (RPMs) and handheld radiation detection instruments were analysed for conformity [4]. Unified test procedures for testing radiation detection instrumentation were developed, contributing to the IAEA efforts to standardize border monitoring equipment.

The experience of the Pacific Northwest National Laboratory in the selection and deployment of RPMs at the US border has been summarized [5]. Being of direct interest and value to the IAEA international programme on the improvement of border monitoring, it was used for the development of type test procedures. This activity was supported by a workshop at the European Commission Joint Research Centre (JRC) in Ispra, where multiple instruments were used to evaluate test specifications and associated test procedures.

As a result of this work, technical guidance was published by the IAEA in the IAEA Nuclear Security Series in 2006 [6]. The publication provides a set of technical specifications for vehicle and pedestrian RPMs, RIDs, personal radiation detectors and neutron search detectors. The minimum requirements of these standard and type test procedures described in the document can be used in design, testing, qualifying and purchasing border radiation monitoring equipment.

3.2. Improvement of RIDs

Specific problems associated with radionuclide identification devices, such as low usability under field conditions, poor reliability of identification results due to weak spectroscopic performance and inadequate analysis of raw data were addressed by several participants of the CRP. Thus, usability issues were discussed in the Usability Guide for Manufacturers of Radiation Monitoring Devices [7]. In order to enlarge a library of isotopes, which an RID can identify, gamma spectra of various radiation sources using NaI and $LaBr_3$ detectors were measured [8, 9]. Special attention was paid to the spectra of special nuclear materials, which are usually not accessible by vendors.

In Ref. [10], MCNP simulations are described that were carried out: (1) to model the emission characteristics of relevant specific gamma lines and of the bremsstrahlung emitted from different geometries of sources of HEU, LEU, NU and DU materials under various gamma shielding; and (2) to model the characteristic gamma responses of typical scintillation detectors (NaI) as used in handheld monitors. The limits of the identification of uranium under shielding by gamma spectrometry were defined.

3.3. New technologies for nuclear security applications

A comparative study of new scintillation materials in applications for border monitoring was undertaken by the group of researchers from the Soltan Institute [11]. The research covered a study of new $LaCl_3$:Ce [12] and $LaBr_3$:Ce scintillators that show a superior energy resolution in gamma spectrometry; new heavy CWO and CaWO scintillators with an efficiency of gamma ray detection comparable to that of a BGO scintillator; and a ^{6}LiI(Eu) [13] crystal in thermal neutron and gamma ray detection using modern detection systems. The study confirmed the superior energy resolution of $LaCl_3$:Ce (above 100 keV) and $LaBr_3$:Ce scintillators, the superior detection efficiency of CWO and CaWO crystals, and also a high linearity of the response.

Particularly, the comparative study of $LaBr_3$ and CZT detectors of comparable size showed a better energy resolution of $LaBr_3$ [14]. A poor charge collection in a large CZT still limits the obtainable energy resolution. More efforts are necessary for further development of larger volume CZT detectors with an energy resolution similar to that measured with small detectors.

To utilize the full capabilities of the $LaBr_3$ detector, photomultipliers with a reduced number of linear focused dynodes to seven or eight stages and characterized by high quantum efficiency of about 35% are required.

3.4. Development of new instrumentation

A group from the Scientific Engineering Center Nuclear Physics Research [15] improved the neutron sensitivity of a handheld neutron search detector to match the sensitivity of RPMs, thus enabling verification of a neutron radiation alarm. Monte Carlo optimization and a feasibility study of various types of neutron detectors (e.g. ^{10}B, ^{3}He, ^{6}LiI(Eu), BC-501A) followed by manufacturing of the prototype has resulted in the development of a high sensitive neutron search detector. The instrument incorporates ^{3}He proportional counters in a polyethylene block, a microprocessor, a graphical display and rechargeable batteries (Fig. 1). The result of the performance evaluation, done by IAEA experts, was used for development of the IAEA specifications [6] on neutron search detectors.

A feasibility study of a ^{6}LiI(Eu) based scintillation detector for implementation in RID and SPRD was performed. The attractiveness of the lithium iodine detector for detection of nuclear and radioactive material is shown in Ref. [16]; it allows simultaneous and separate detection of gamma rays and neutrons. Prototypes of RID KSAR1U.05-03 "SIGMA-n" (Fig. 2) and

FIG. 1. NSD, matching sensitivity of RPMs.

FIG. 2. ^{6}LiI(Eu) detector based radionuclide identifier.

FIG. 3. ^{6}LiI(Eu) detector based spectroscopic PRD.

SPRD KSAR1U.08 “SIGMA-n personal” (Fig. 3) were built and sent to the IAEA for further evaluation.

The aim of the research group from Latvia [17] was the development of a ‘ruggedized’ detection probe for field use with a large volume coplanar CdZnTe detector to enhance efficiency of detection. Two coplanar grid detectors were fabricated with application of the technology developed for the fabrication of pixel and strip detectors. The energy resolutions achieved were 8.2 keV on 59.9 keV (13.8%); 8.04 keV on 122 keV (6.6%); 11.4 keV on 662 keV (1.72%); and 16.0 keV on 1332 keV (1.2%), respectively. The sensitivity of the CZT2-4-2 detector for ^{137}Cs was ~18 mm^2 for irradiation from the grids and ~16 mm^2 from the end face.

Under the research agreement, FZR Research Center Rossendorf [18] conducted a feasibility study of a miniature isotope identifying a gamma spectrometer for covert detection and categorization of radioactive materials.

The instrument incorporates all the standard features of the RID — spectroscopic CZT, 10 mm × 10 mm × 5 mm gamma ray detectors with a resolution of 25 keV for ^{137}Cs, a 2k multichannel analyser, a low power micro-processor and an LCD with a form factor of a wristwatch (Fig. 4). A specialized algorithm for radionuclide identification was developed [19]. The instrument identifies a single, unshielded nuclide producing a dose rate of 1 μSv/h above background within 300 s in an energy range up to 800 keV, and within 600 s in an energy range up to 1.6 MeV.

The form factor of the instrument has allowed the instrument to be used with an air robot to detect and categorize radiological dispersing devices.

FIG. 4. Miniature SPRD wristwatch.

3.5. Detection of shielded SNM and other radioactive material

The challenges associated with detecting masked or shielded high enriched uranium using active interrogation methods were addressed by two research groups from Idaho University, USA, and the V.G. Khlopin Radium Institute, Russian Federation. The group first implements the pulsed photonuclear assessment method being developed at Idaho National Laboratory in collaboration with Idaho State University's Idaho Accelerator Center and Los Alamos National Laboratory [20–23] (Fig. 5).

The sensitivity of the method and the set-up developed correspond to the detection of 5 kg of depleted uranium inside 5 cm of lead at a standoff distance of 8 m within 120 s.

The second group has been working on the development of the associated particle technique for detection of shielded nuclear materials [24], based on irradiation of the inspected volume with 14 MeV neutrons from a miniature DT neutron generator with a built-in detector of associated α particles, and detection of fission neutrons and gamma rays in coincidence with α particles, that accompany emission of primary neutrons in the $D + T \rightarrow n + \alpha$ reaction.

Detection of associated α particles allows the determination of the emission time and flight direction of each primary 14 MeV neutron. Measurement of secondary particles (neutrons and gamma rays originating from induced fission of nuclear materials) in coincidences with these 'tagged' neutrons in very narrow (tens of nanoseconds) time 'windows' allows the suppression of the background, which is associated with primary 14 MeV

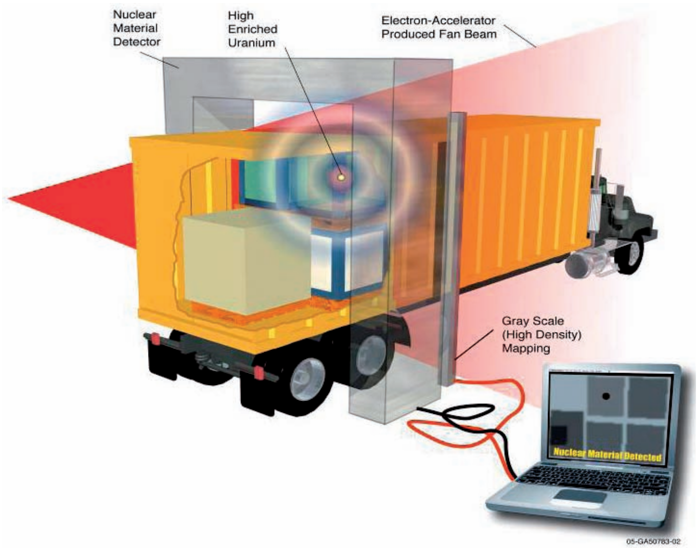

FIG. 5. Pulsed photonuclear assessment method being implemented at Idaho National Laboratory.

neutrons and their (n, 2n) and (n, α) reactions on surrounding materials [25]. Experimental work using three neutron detectors (Fig. 6) for detection of triple (n-n-α) and quadruple (n-n-n-α) coincidences between neutrons from induced fission of shielded fissioning materials is currently under way.

3.6. Innocent alarms and fast verification of NORM

While radiation monitoring equipment has been used for over 20 years at nuclear facilities, the installation of this equipment at airports, border crossings and ports has disclosed some unique problems. For these installations, the frequency of 'innocent alarms' due to common, non-illicit materials (or individuals who have had medical or diagnostic treatments using radioisotopes) that routinely pass through the monitor sites has been problematic. The possibility of discriminating against medical isotopes was examined during this CRP, and initial successes were documented. Thus, one work goal [18] was to develop an approach of flagging innocent alarms caused by medical isotopes for cases when a conventional pedestrian monitor would give a gamma alarm. Based on a large volume NaI(Tl) detector 15.2 cm × 5.1 cm coupled with a fast multichannel analyser and identification software running on the laptop, the system showed a gamma sensitivity that compares well with that of a gross

FIG. 6. Experimental set-up involving the associated particle technique for detection of shielded SNM.

gamma counter. However, it has the advantage of providing the spectrometric information, allowing the identification of isotopes. Therefore, a new generation of spectral portal monitors for monitoring pedestrians has been developed and demonstrated. The decision to be made in the situation of a green alarm indication is still the responsibility of the user (manual follow-up or not, depending on the threat level). However, this monitor cannot fully replace an RID, which is still needed for verification of 'red' alarms.

The developed system was tested at Vienna International Airport at Schwechat, Austria. In 241 d of data collection, the instrument recorded 163 events: 154 medical sources, three NORM sources (stones and minerals) and five non-identified events. In addition to the experimental evidence of the high efficiency of the 'real time identification approach', the results of the run confirmed the high rate (96%) of innocent alarms at the border.

Another severe problem at the border is the discrimination of alarms caused by NORM from those due to illicit movement of materials. These NORM alarms, typically found at sites where cargo routinely pass, impede the natural flow of commerce and limit the effectiveness of the radiation monitors. The second group from the Institute of Nuclear Physics of the Academy of Sciences of Uzbekistan studied detection and fast verification of NORM in tracks [26].

The system developed incorporated a 100 mm × 50 mm NaI(Tl) crystal based detector and the appropriate software for the automatic identification of

FIG. 7. A highly sensitive NaI(Tl) detector for fast verification of NORM in trucks.

nuclides in the transportation means at stand still by real time identification of the spectrum from the NaI(Tl) detector.

The developed method was tested at several border crossing points in Uzbekistan [27], showing the validity of such an approach.

3.7. Verification of legal shipments and masking

There are three basic scenarios, which could be considered effective to foil detection capability of border monitoring equipment. They are: (1) masking the presence of illicit nuclear materials with widely used radiopharmaceuticals (^{99m}Tc, ^{131}I, ^{67}Ga, etc.) or industrial isotopes (^{137}Cs, ^{60}Co, ^{192}Ir, (α, n) sources, etc.); (2) shielding with heavy containers; (3) legal shipment to substitute attributes of the declared material — isotopic composition or quantity. The philosophy behind these scenarios is to prevent, or confuse the FLOs frontline officers with RIDs from obtaining the positive signatures that they require to unambiguously identify the radioisotopes of concern.

Three contracts and agreements have addressed these issues. The research group from the Australian Nuclear Science and Technology Organization completed a three stage scientific programme to experimentally investigate different scenarios that could potentially be used to mask the presence of illicit nuclear materials. The first two stages were concerned with the masking of HEU and plutonium when detected by different types of gamma ray detectors: HPGe, CZT and NaI. The third stage [28] investigated the comparative performance of the RID and HPGe detector to detect masked material. A variety of test scenarios were formulated which involved the combination of nuclear material with other gamma ray emitters and a combination of different shielding material configurations.

When the type of shipping container is known, the attribute analysis of the content is much easier. The group from VNIIA, Russian Federation in cooperation with the State Customs Committee developed an approach of legal shipment verification [29]. The database of standard shipping containers in combination with HPGe detectors has shown the reliability of the verification method for isotopic and quantitative analysis of the radioactive enclosure.

The most difficult case — activity verification inside an unknown shipping container was studied [30] by analysing the shape of the Compton continuum of the gamma ray spectrum behind shielding. The approach was tested experimentally with lead, steel and tungsten containers from 3 to 50 mm wall thickness for ^{152}Eu, ^{137}Cs, ^{60}Co, ^{133}Ba, ^{88}Y and ^{22}Na. The accuracy of the proposed method was found to be sufficient for the primary attribute test of the activity.

4. CONCLUSION AND THE WAY FORWARD

At the third and closing research coordination meeting, the conclusion was drawn that although significant progress has been made in the development of tools to combat nuclear smuggling, further research in several different areas is still required. The detection capability of existing systems is not the area where more development is needed. The development of the capability to discriminate real illicit trafficking from the movement of NORM or medical isotopes is the area that requires the most improvement. This research should not only concentrate on better isotopic identification systems but should also include the development of tools for better information distribution and communication. There is a need to increase the capability of the inspection agents to resolve alarms by developing improved ‘reach back’ capabilities. The agents desperately need an enhanced capability to acquire help from experts with higher levels of training in the use of radiation detection equipment and the interpretation of data from these devices. Operational experience has shown that no amount of training can prepare the field agent for all of the radiation alarm scenarios. ‘Reach back’ capability is essential for effective operation of the monitoring systems. The capability could be improved by developing better standardized data formats, data transmission proficiency and data analysis tools.

As a way forward and as a logical extension of the previous CRP, the IAEA established a follow-up CRP on “Development and Implementation of Instruments and Methods for Detection of Authorized Acts Involving Nuclear and Other Radioactive Material”.

The main goal of the follow-up CRP is to assist Member States to develop and implement an effective, efficient and sustainable system to counteract nuclear terrorism. The topics considered important are:

— Evaluation of new radiation detection technologies to improve the confidence of isotope identification;
— Detection of shielded HEU, identification of nuclear material masked with NORM or medical isotopes;
— Radiological security of major public events: covert radiation surveillance and detection in a crowd;
— Mobile radiation detection systems for random patrolling of ‘green’ borders;
— Further development and implementation of ‘reach back’ mobile expert support;
— Updating technical specifications for nuclear security instrumentation;
— Improvement of equipment quality through rigorous acceptance tests.

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ILLICIT TRAFFICKING
The importance of testing and qualifying equipment

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Abstract

Fighting the illicit trafficking of nuclear material also means putting increased effort into detection capabilities. The international community is deploying a great effort in addressing this issue, in particular by supporting beneficiary countries in developing, enhancing and upgrading their capabilities. Equipment for the detection of nuclear and radioactive materials at crucial nodal points is provided worldwide by major donor States. The European Commission especially through its Joint Research Centre (JRC) is a key player in the field, as demonstrated in the Technical Assistance to the Commonwealth of Independent States (TACIS) programme and as foreseen in the Instrument for Stability (IfS). Within these two programmes, the JRC supports the fight against illicit trafficking of nuclear and radioactive materials, and is implementing specific projects dedicated to border monitoring. In its green paper on detection technologies adopted in 2006, the European Commission attempted to put forward ideas on how to improve the access of law enforcement authorities to high quality detection tools. Testing and qualifying the related equipment remain crucial for the credibility and usefulness of technology in the field of combating the illicit trafficking of nuclear and radioactive materials.

1. INTRODUCTION

After the disintegration of the former Soviet Union, an increasing number of cases of illicit trafficking of radioactive and nuclear materials has been observed. Most of the seizures of nuclear material were reportedly due to information obtained through secret services. It was only in a few cases that radiation detection systems revealed attempted clandestine movement of nuclear materials. The area of illicit trafficking of nuclear material has gained significantly higher attention after the events of 11 September 2001 and the frightening idea of nuclear terrorism.

Illicit trafficking in nuclear materials has become more and more of international concern also due to the circulation of a high number of radioactive sources and the large amount of nuclear materials stored. Member States are increasingly seeking technical advice and assistance from the IAEA in their efforts to establish and upgrade their national technical capabilities to detect and respond to the illicit trafficking of nuclear material and other radioactive materials. Of particular interest are the detection and characterization of nuclear and other radioactive materials seized at borders, other points of entry and inside States, as well as the response to the seizure of such materials. Fighting illicit trafficking of nuclear material indeed means putting increased effort in detection capabilities. The international community is deploying a great effort in addressing this issue, in particular by supporting beneficiary countries in developing, enhancing and upgrading their capabilities. Equipment for the detection of nuclear and radioactive materials at crucial nodal points is provided worldwide by major donor States.

The European Commission, in particular through its Joint Research Centre (JRC), is a key player in the field, as demonstrated in the Technical Assistance to the Commonwealth of Independent States (TACIS) programme and as foreseen in the Instrument for Stability (IfS). Within these two programmes, the JRC supports the fight against illicit trafficking of nuclear and radioactive materials, and is implementing specific projects dedicated to border monitoring. In its green paper on detection technologies adopted in 2006, the European Commission attempted to put forward ideas on how to improve the access of law enforcement authorities to high quality detection tools.

Testing and qualifying the related equipment remain crucial for the credibility and the usefulness of the technology in the field of combating the illicit trafficking of nuclear and radioactive materials.

2. ILLICIT TRAFFICKING RADIATION DETECTION ASSESSMENT PROGRAM EXPERIENCE

The experience of the Illicit Trafficking Radiation Detection Assessment Program (ITRAP) (1996–2000) [1] resumed what was the state of the art of portals, pagers and handheld devices for on-site radioisotope detection and identification. It was carried out by the Austrian Research Centers Seibersdorf (ARCS) and supported by the IAEA, the World Customs Organization and INTERPOL, and participation of the European Commission through the JRC. International suppliers and manufacturers of nine different countries, such as Austria, Belarus, Canada, France, Germany, the Russian Federation, Sweden, the United Kingdom and the USA initially participated in the ITRAP study.

The purpose of this exercise was not to compare instruments but mainly to catalogue the individual sensor capabilities and abilities to detect and identify unshielded and shielded sources (Fig. 1). Criteria of evaluation were set (detection distance, false alarm rate, isotope identification, distance from the source, measurement time, etc.). The main conclusions were that only 7 of 14 fix-installed monitoring systems (50%) passed the ITRAP laboratory test. For the pocket type and handheld instruments, only 13 of 24 instruments or instrument combinations passed the ITRAP laboratory tests. Concerning isotope identification, no instrument has met the minimum requirements, particularly concerning the effect of shielding of radioactive material. The energy resolution of the detectors was not the only issue and high efficiency detectors were necessary for the source search and isotope identification when radiation sources were contained in large objects. Many questions were raised and considered crucial, such as how the instrument deals with background, multiple sources and innocent alarms caused by the presence of large quantities of naturally occurring radioactive material (NORM) or medical radioisotopes.

3. IAEA RELATED COORDINATED RESEARCH PROJECT

The consultants meeting in preparation for the coordinated research project (CRP), Improvement of Technical Measures to Detect and Respond to Illicit Trafficking of Nuclear Material and other Radioactive Materials, took place at the IAEA headquarters on 22–26 April 2002. Participants from Australia, Austria, Germany, the Russian Federation, the USA, JRC Ispra and JRC Karlsruhe, and the IAEA discussed the major topics and objectives of this CRP. The overall objective was to enhance ongoing national and international efforts to combat nuclear smuggling and, therefore, to coordinate the scattered research activities. In particular, it is to obtain improved equipment to detect the illicit trafficking of nuclear and other radioactive materials, and to properly respond to the interdiction of these materials by law enforcement authorities. The participants have discussed proposals for research agreements and contracts, and have suggested contractors.

Among these contracts, the JRC has been in charge of the following three topics:

- Delivery of a gamma spectra library of measurements on various radiation sources, industrial gamma radiation sources and special nuclear material (Pu, HEU, U, etc.) using a NaI detector [2];
- Delivery of a gamma spectra library of measurements on various radiation sources using a $LaBr_3$ detector [3];
- Monte Carlo modelling of shielded and non-shielded uranium source gamma spectra from the NaI detector [4, 5].

During this meeting, specifications of border monitoring equipment and associated type test procedures were also drafted.

During the period 22 April–2 May 2003, the consultant group undertook the task of organizing the so-called 'tests of test procedures'. The goal was to check the IAEA Functional Specifications for Border Radiation Monitoring Equipment, drafted by the consultant meeting of March 2003, to check the associated test procedures and to revise the specification document. The tests had to be performed in a cooperative effort of experts and vendors.

The tests were performed in the Performance Laboratory (PERLA) of the JRC Ispra, Italy, by technical experts from Austria, Canada, the Czech

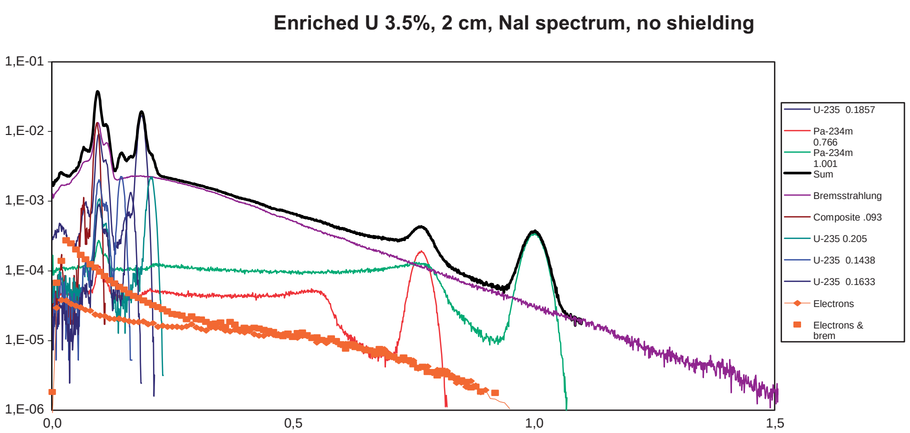

FIG. 1. Partial and final detector responses from 2 cm UO_2 source without shielding.

Republic, Germany, the IAEA, JRC Ispra, the Netherlands, the Russian Federation and the USA (Fig. 2). The large inventory of nuclear materials and other radiation sources available for testing at this laboratory contributed to the success of this exercise and clearly proved that border monitoring equipment has been considerably improved since the state of the art at the time of the ITRAP tests. Five manufacturers from four Member States delivered equipment and provided the necessary staff for installation and operation for the full time of the tests at their own expense.

The equipment of concern was one vehicle monitor with NORM recognition capability, one pedestrian monitor, three handheld isotope identifiers, three new generation neutron/gamma personal radiation detectors, one handheld gamma detector with NORM recognition capability and one handheld neutron search instrument.

The major result was that the sensitivity specifications for portal monitors can be lowered for nuclear materials by an order of magnitude (relative to the ITRAP minimum requirements). For handheld isotope identifiers, new and stricter specifications were established and tested: a Pu source in a 10 mm lead container; mixtures: Pu/^{133}Ba, Cs-U, NORM. New specifications were established and tested for neutron/gamma pagers, handheld neutron search devices, identification of lead shielded Pu samples, NORM detection limits and new NORM suppression methods used in portal monitors, and finally specifications/test procedures for other instruments were validated [6].

This exercise showed the importance of effort combination and collaboration of experts, users and vendors as the most effective way to move ahead in improving specifications and technology. Access to nuclear material (PERLA)

FIG. 2. Testing of portal equipment took place at JRC Ispra.

and other sources is essential, and drafting of specifications and test procedures without practical verification is not valid.

4. RECENT TESTS

Recently, in collaboration with Seibersdorf ARC, 16–18 May 2007, new tests were performed by the IAEA on spectral radiation portal monitors. This technology is proposed as a solution to the high rate of innocent alarms (Fig. 3). Two companies participated in these tests. Although the results clearly showed the excellent capability of the equipment to identify single isotopes, none was able to identify nuclear material masked with medical radioisotopes producing the same or a higher dose rate as the SNM material. This demonstrated that both hardware and software need to be improved to fully meet the user requirements.

FIG. 3. Spectral radiation portal monitors as a solution to the high rate of innocent alarms.

5. THE FUTURE

5.1. The ITRAP+10 project

A large amount of equipment is already in operation today and experience has been gathered with respect to innocent alarms, due to NORM and medical isotopes. Shielded and masked isotopes remain a serious problem. The JRC and the ARC with the support of the IAEA are planning the organization of the new ITRAP+10 project. The JRC will involve experts from two institutes and will provide the necessary, well characterized nuclear materials and radioactive sources. The JRC will also provide the infrastructure (e.g. PERLA at JRC Ispra). The ARC and the IAEA laboratory in Seibersdorf will be in charge of the tests for radioactive materials (repeating the ITRAP collaboration scheme). The IAEA will also contribute to the specification of the test programme.

5.2. Certification

The creation of a European wide certification scheme is also being seriously considered by the European Commission. A detection solution (including a system) or other mechanism of detection could be certified by accredited laboratories/organizations in the member States. This test would be accepted by all member States. The information on the results would be exchanged among relevant public authorities in the member States. A precondition for certification is the existence of minimum performance requirements for situations in which such requirements are needed and necessary. This should be based on scenario settings and evaluation of risks, threats and vulnerabilities. The procedures and tests used during the ITRAP+10 exercise, in addition to the International Electrotechnical Commission standards, would be certainly considered in any future European Commission certification scheme.

6. CONCLUSION

Testing and qualifying equipment will not only serve the assessment of the significant gaps between the requirements and performance of the equipment but will also contribute to:

- Assessment of the technology: What is affordable and what is the wishful thinking of the users?
- Bringing the equipment closer to the required performance;

— Triggering the development of procedures and standards;
— Launching new R&D projects that lead to new equipment and software, and advanced technology to the field of the detection and identification of nuclear materials;
— Avoiding duplication of activities across the member States, which would result in a waste of public and private sector resources; testing is a costly, time consuming process that requires well qualified staff;
— Enabling access to information for member States who do not have their own capacities to perform testing.

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IAEA-CN-154/004

DEVELOPMENT AND IMPLEMENTATION OF A PLASTIC SCINTILLATOR BASED FACILITY FOR COUNTING COINCIDENCES OF FISSION PARTICLES FROM FISSILE MATERIALS

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Abstract

The work described in the paper was performed under ISTC Project No. 2978. The method used is counting the coincidences of neutrons and photons in plastic scintillators occurring at fission of fissile materials (FM) in AT-400 type containers. A pulsed neutron source and digital processing of experimental results are applied. The paper provides preliminary experimental results, demonstrating the feasibility of a multipurpose facility for the control and detection of FM.

1. INTRODUCTION

Facilities that count time coincidences of neutrons and photons occurring in the fission of fissile materials (FM) can use an AmLi source of neutrons, for example, as is the case with the AWCC system [1]. The use of this neutron source is explained by the fact that emerging particles have no time correlation, and a considerable fraction of neutrons in their spectrum is in the energy region below the ^{238}U fission threshold. The disadvantages of the facility are related to the issues of a radioisotope source operation. Those include the impossibility to shut down the neutron flux during the downtime and transportation of the facility, as well as the necessity to guard the source. In addition, the measurement chamber of the facility is insufficiently large to inspect FM samples placed in protective AT-400 type containers; also, if the source is damaged, the premises could be contaminated. Elimination of these disadvantages concurrently with increasing the informativeness of the coincidence count systems can be achieved by the use of digital technology to detect the response of FM neutrons and photons in fast scintillation systems, and application of a DD neutron generator. The use of scintillators also allows the detection of fission photons, beside neutrons, which increases the multiplicity of particles and, hence, the efficiency of the facility.

2. NEUTRON AND PHOTON TIME COINCIDENCE COUNTING FACILITY

In scintillators with a short de-excitation time, the whole amplitude–time sequence of FM response scintillation pulses induced by fission neutrons and photons can be saved in the computer memory using analogue to digital converters. Digital boards with a digitization rate of 100–1000 MHz can be used, which means recording scintillation pulses with a time step of 1–10 ns. With this form of response detection, the requirements to the dead time of the facility decrease, as the subsequent software processing of the whole signal sequence allows the arrival time of any individual scintillation pulse to be obtained mathematically, even taking into account their possible pile up [2–4].

The studies related to the development of the scintillation facility for counting fission neutron and photon coincidences were carried out on the breadboard models designed and implemented under ISTC Project Nos 596 and 2978.

The detectors of a fast neutron and photon coincidence system should have high sensitivity to the radiation to be registered in a wide energy range at a high time resolution. These requirements are met by the plastic detector.

The four detectors used in the studies had a square parallelepiped shape, 500 mm long and 50 mm thick; they allowed registering fast neutrons in the energy range ~0.5–14 MeV and photons in the energy range ~0.03–6 MeV, as well as determining the moment of pulse registration with an accuracy of a few nanoseconds. Each detector was in the viewing range of two photomultipliers such as FEU-30 located symmetrically on one of the narrow faces of the detector at a distance of 120 mm from the edges.

The detectors were assembled in a quadrangular structure, thus producing a cubic measurement chamber inside. For the facility to be capable of working both in passive and active modes, it was designed in two versions. For the work of the facility in the mode of active control on thermal neutrons, a hydrogen containing neutron moderator and pulsed DD neutron generator were placed at the open side of the chamber. The FM samples to be assayed were placed in the centre of the hydrogen containing moderator of the facility. Inside the facility, lead shields up to 50 mm thick could be located; in this case, the coincidence events corresponded primarily to fission neutrons. This approach reduces the multiplicity of radiation; however, the effect of FM shielding decreases. The version of the facility with a pulsed neutron generator is shown in Fig. 1.

The analysis of double coincidences was carried out using a specially developed program based on a statistical method [5]. Obviously, in the case of application of a digital system, any other algorithm could be applied for the

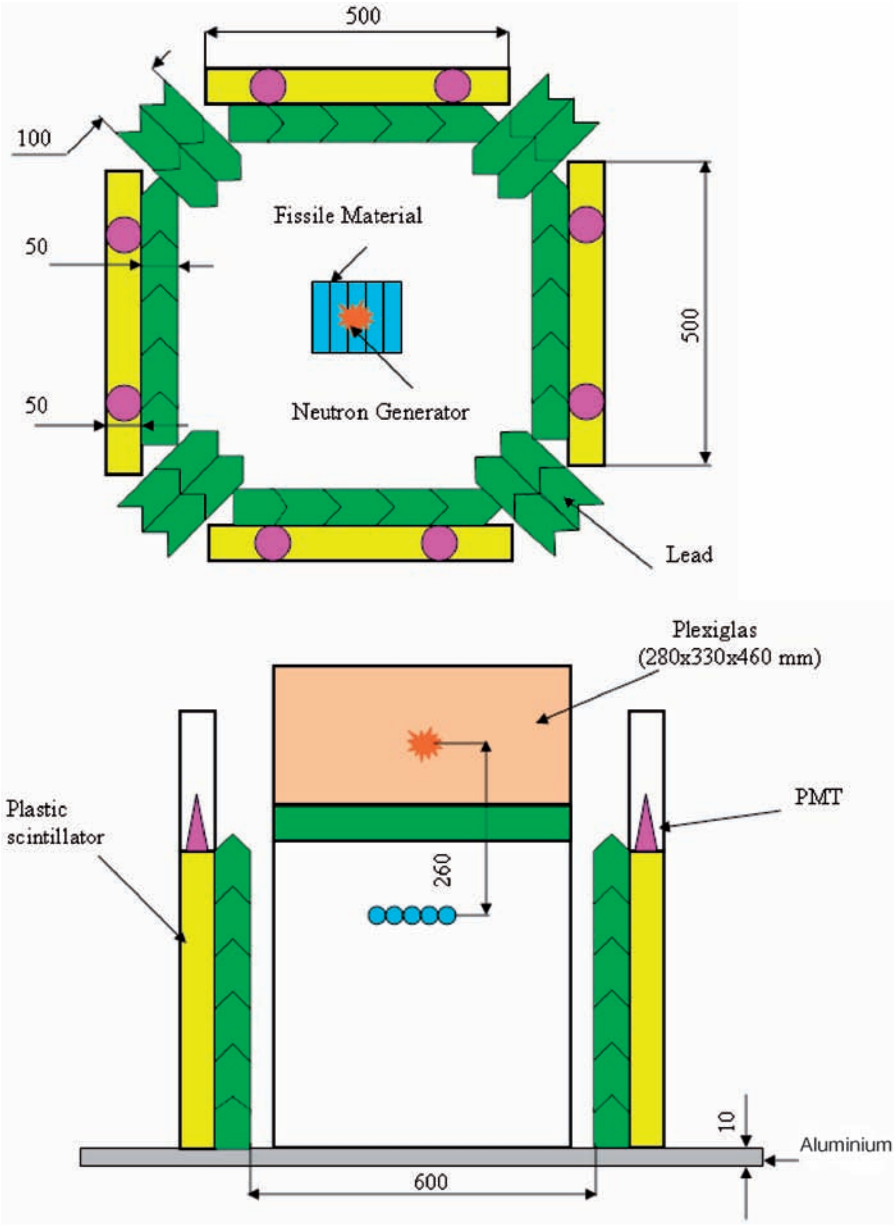

FIG. 1. Geometry of the experimental facility for the study of the number of coincidences of fission particles from uranium samples with use of a pulsed neutron source.

determination of coincident events of any multiplicity. The facility works as follows. A few microseconds after a 1 μs pulse of neutrons from the source, the neutrons slow down in the facility to thermal energies, and their flux reduction corresponds to their time decay constant determined by the geometrical and material characteristics of the facility. The occurring thermal neutrons split the FM nuclei. These include ^{233}U, ^{235}U and ^{239}Pu. The FM fission response consisting of neutrons and photons is detected by four plastic scintillators, each having its own digital system for recording the amplitude–time sequence of the response. The system of all four time channels is synchronized by its start time. A record of the digital signals of the system is shown in Fig. 2. This record of synchronized signals allowed calculating coincidences of fission particles using various algorithms. For the presented facility and AWCC system, dependences

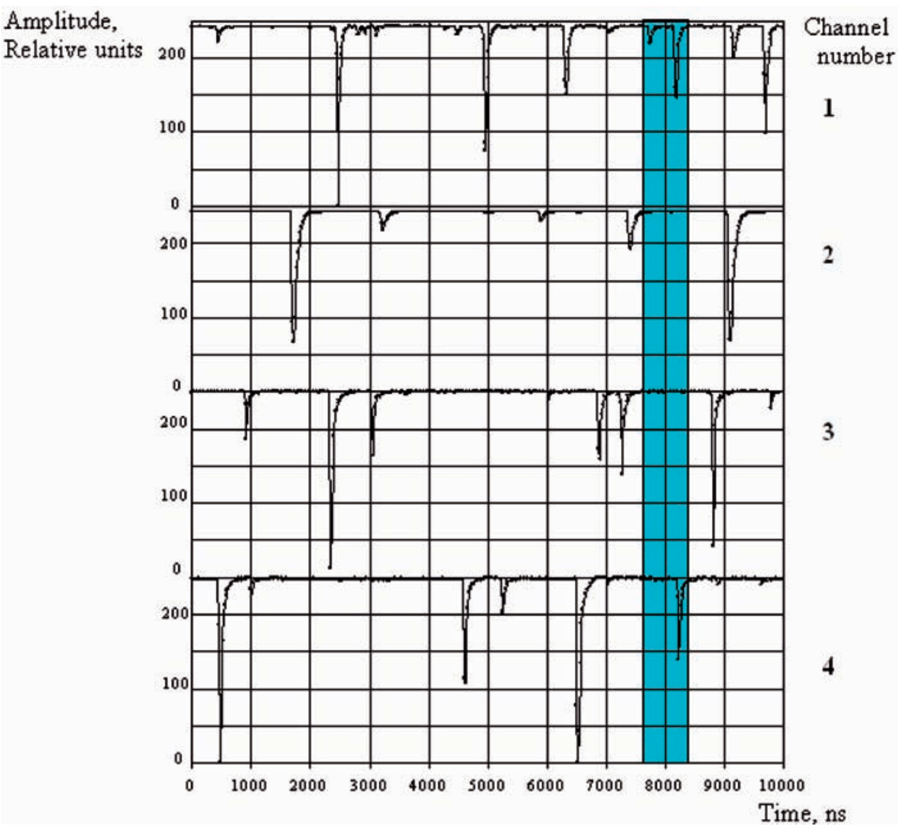

FIG. 2. Spectrogram of neutron and photon pulses digitized with a four channel registration system.

of the number of coincidences on ^{235}U mass have been obtained. The results presented in Fig. 3 show their sufficiently good coincidence.

In the next phase of ISTC Project No. 2978, preliminary measurements were carried out, which confirmed the applicability of the facility in passive mode for the detection of ^{240}Pu placed in an AT-400 container. In these measurements, only the relative behaviour of the measured quantities was determined. The hydrogen containing neutron moderator was removed from the facility. The facility configuration is given in Fig. 4.

In the measurements, ^{240}Pu was simulated with a ^{252}Cf neutron source, in which the spectrum of the emitted radiation is practically identical to the neutron spectrum of spontaneous ^{240}Pu decay, though the multiplicity of radiation is somewhat different. For experimental studies, containers of 1.5 cm thick boronated polythene and water containers made as parallelepipeds with a shielding water layer thickness of 4, 8, 12 and 16 cm were produced.

The container from boronated polythene with the ^{252}Cf neutron source was placed inside the water containers. The experiments were carried out with different thicknesses of the shielding water layer, as well as with and without an internal layer of lead. The neutron yield of the californium neutron source was ~8×10^4 n/s.

The restriction of the data acquisition time in the facility was determined by the memory capacity of the digital measurement system. The rate of double coincidences (covariation) and triple coincidences (binary covariation) as a function of time interval after the starting pulse for different thicknesses of the shielding water layer is given in Fig. 5. The coincidence rate versus thickness of the water layer of the container is shown in Fig. 6.

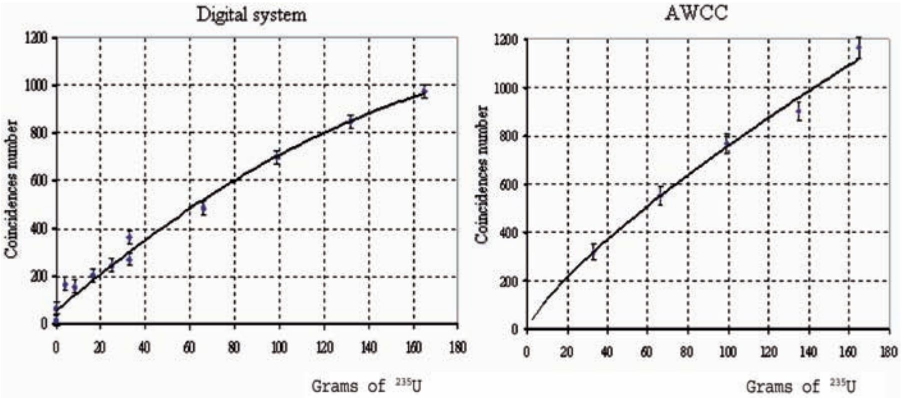

FIG. 3. Double coincidence rate versus ^{235}U mass for two different facilities.

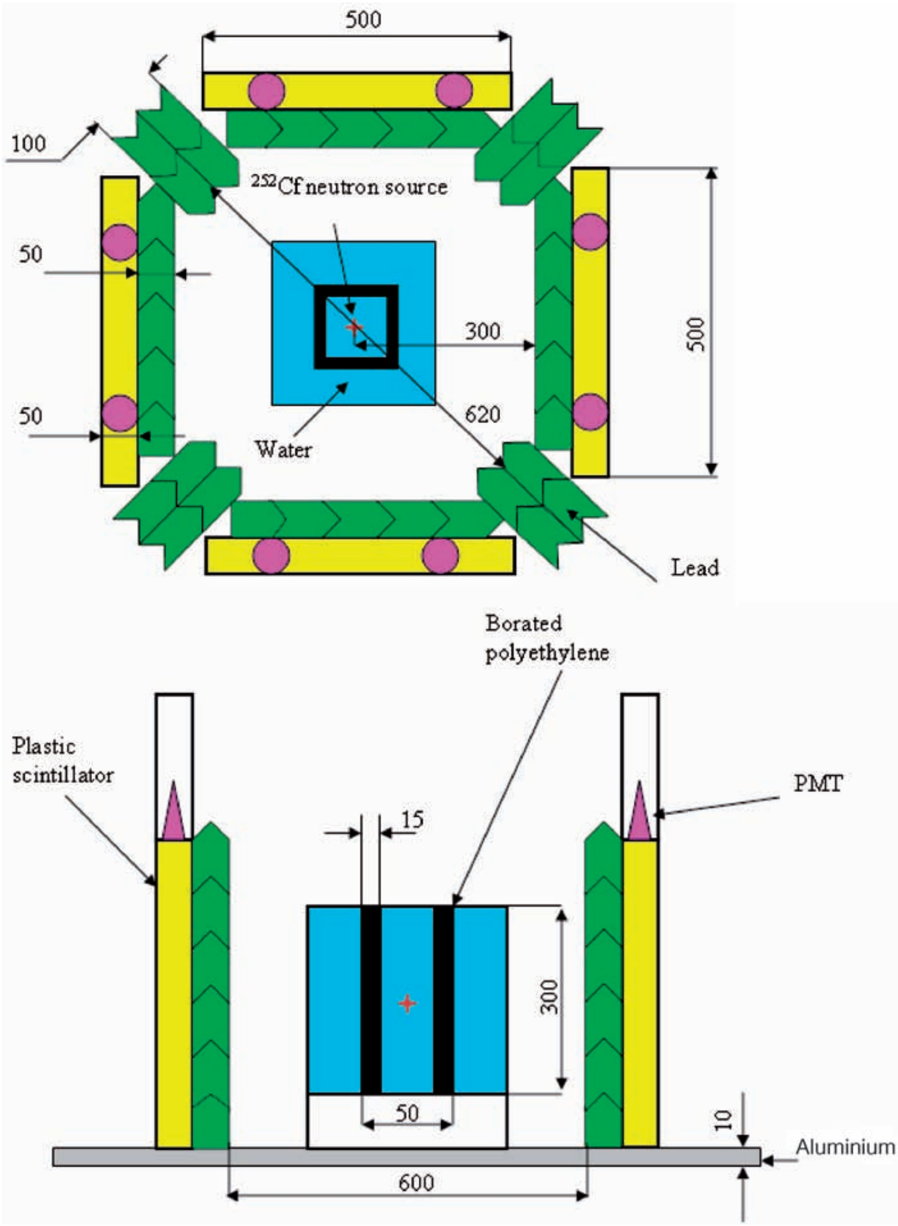

FIG. 4. Geometry of the experimental facility for studies of coincidences of neutrons and photons from a californium source in an AT-400 container model.

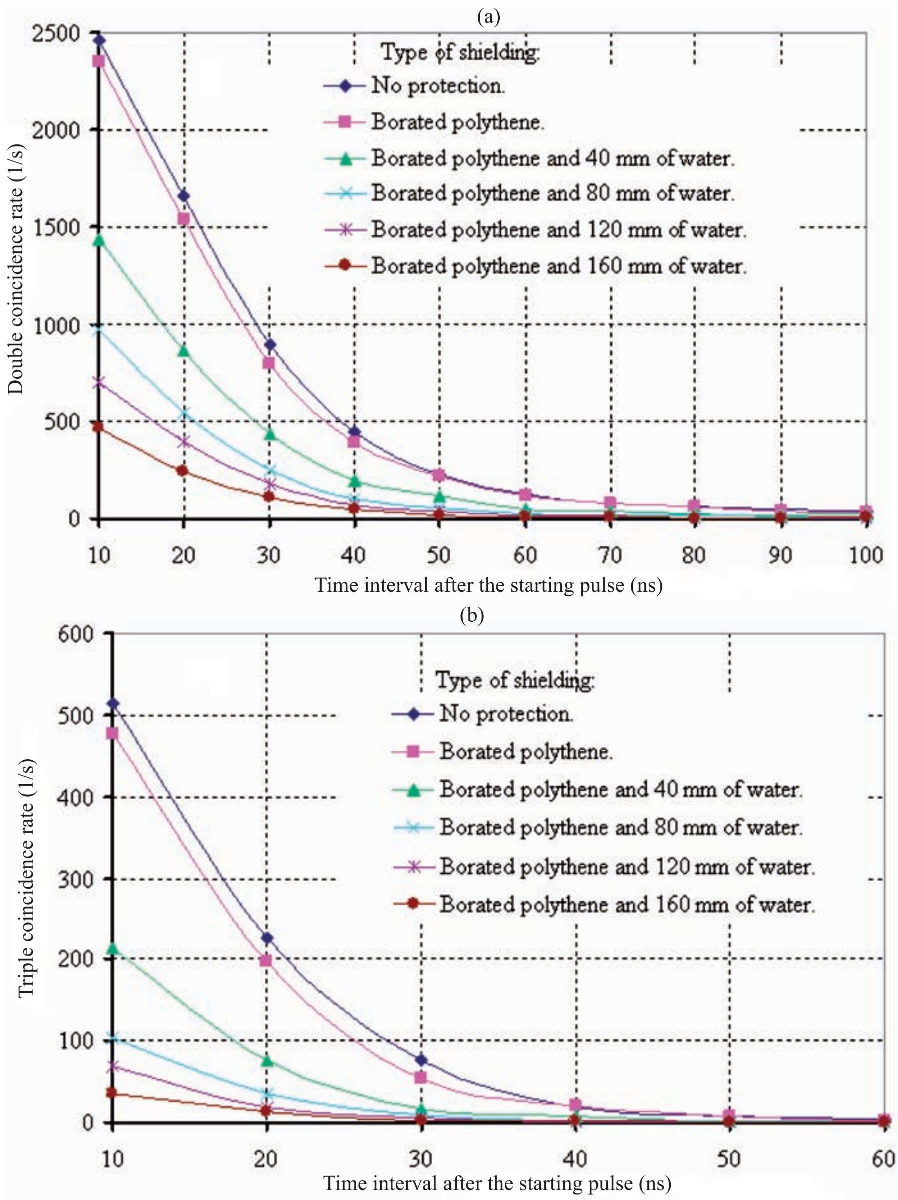

FIG. 5. Double (a) and triple (b) coincidence rate as a function of time interval after the starting pulse for different thicknesses of shielding.

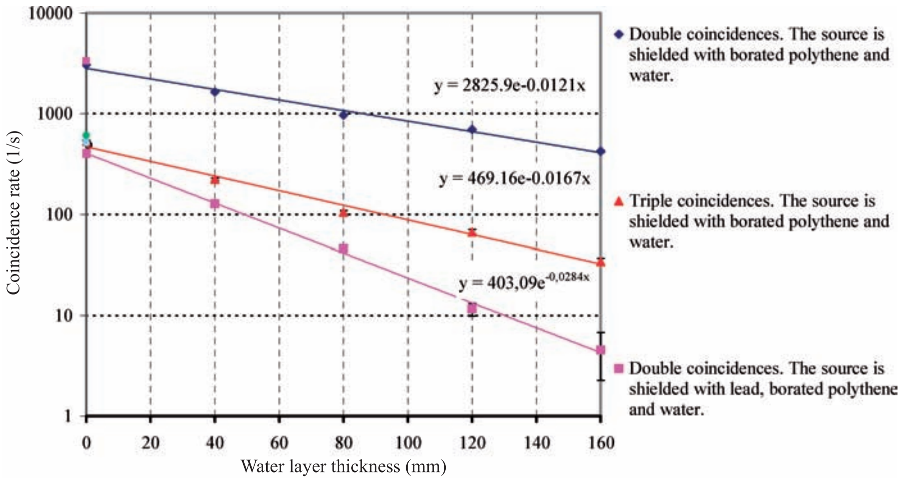

FIG. 6. Coincidence rate versus water layer thickness.

Apparently, these dependences substantially differ from each other, which is explicable with different multiplicities of particles emitted by the sources.

Preliminary experiments have shown that implementing the facility will have the following advantages:

— No radioisotope sources;
— Multipurpose digital data processing;
— Large size of the measurement chamber;
— High efficiency of neutron and photon detection.

The experimental results presented allow the following conclusions to be drawn:

— Pulsed neutron generators were shown to be applicable in facilities intended for counting time coincidences of FM fission particles;
— The passive method of measurement of the number of neutron and photon coincidences depending on the interval of particle detection in the facility with plastic scintillators has been implemented;
— The rates of double and triple coincidences from radiation sources with a different multiplicity of emitted particles have been measured;

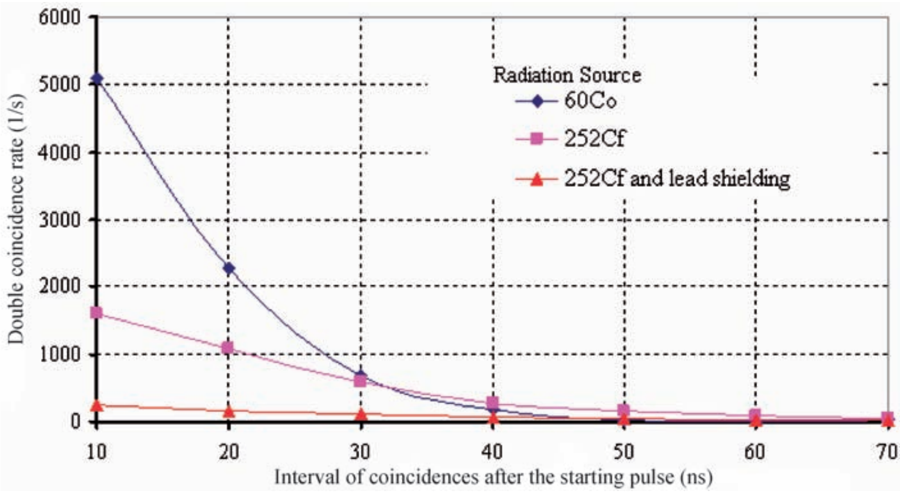

FIG. 7. Ratios of the triple to double coincidence rates as functions of interval after the starting pulse for different sources.

— The possibility of measuring double and triple coincidences from spontaneous ^{240}Pu fission in an AT-400-type container has been shown for different thicknesses of the water layer in the container;

— A possible way to identify the radiation source by the ratio of triple coincidences to double coincidences has been shown.

The results of the experiments have shown the implemented model of the facility to be applicable for obtaining information on quantitative characteristics of spontaneous decay nuclides and gamma radiation sources placed in closed protective containers not to be opened.

The ratios of the triple to double coincidence rates as functions of interval after the starting pulse for different radiation sources are presented in Fig. 7.

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IAEA-CN-154/057

THE POTENTIAL USE OF NATURALLY OCCURRING COSMIC RAY MUONS FOR THE DETECTION OF ILLICIT NUCLEAR MATERIAL AT BORDERS AND PORTS

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Abstract

The paper describes work undertaken by Nexia Solutions regarding the use of naturally occurring cosmic ray muons as a high energy, high penetrative means to image dense or shielded objects. Lead (or similar) shielding would most likely be used to smuggle illicit nuclear material as the lead provides both shielding from incident X rays as well as a means to contain the radiation, thus eliminating the detectability of the material. Because of its superior penetrative power, muon technology offers a means to peer through this lead shielding in order to identify the material within. Nexia Solutions originally developed the technology specifically as a nuclear decommissioning tool to image the contents of shielded silos and vessels containing nuclear waste material. However, the technology is transferable to homeland security applications, more specifically in the non-intrusive real time detection of nuclear material at borders and ports. In the paper, previous work undertaken by Nexia Solutions is described, including modelling enabled material discrimination, two dimensional muon based density

mapping, as well as the design of a relatively inexpensive and deployable muon based imaging system, which may offer an economically viable means to deploy the technology for the detection of illicit nuclear materials at borders and ports.

1. INTRODUCTION

Various techniques are currently being implemented at ports and borders to detect and prevent the transport of weapons of mass destruction (WMD) and the illegal movement of radioactive material that could be used for malicious purposes. States face a 'challenging' situation where national and regional interests need to be protected whilst trade interactions between States must continue and be allowed to expand to suit ongoing world trade relationships. Timely and effective monitoring/detection measures are therefore essential to ensure this challenge is effectively achieved in practice. Nexia Solutions Limited is currently a wholly owned research and development subsidiary of British Nuclear Fuels Limited (BNFL). BNFL is a United Kingdom Government owned company. Nexia Solutions researchers have developed a new technique that could be fundamental in the improvement of detection of radioactive materials significantly concealed in vehicles/transport containers at port/border facilities that would not normally be detected by existing radiation monitoring equipment. This technique would not replace current radiation detection techniques but could supplement these by offering an 'off-line' (remote) scrutiny of suspect packages/containers, etc. for better identification of illicit trafficking and suspected concealment of radioactive materials.

In recent years, muon technology has been developed within the nuclear industry specifically for the non-intrusive inspection of heavily shielded storage vessels and containers. Until recently, the radiation shielding, which is usually used to conceal nuclear material, has rendered existing remote non-intrusive imaging techniques useless. This is due to the limiting penetrative power of X rays and gamma rays as well as lack of access for other semi-invasive techniques such as electrical and acoustic imaging. It is the muons' ability to penetrate shielding which makes it so attractive. This is because muons have very high energies (up to 10^{12} GeV) and therefore offer a superior penetrative power which provides a means to 'peer through' objects which otherwise would be inaccessible. The attenuation characteristics of vertical sea level muons have previously been quantified for lead [1] and are summarized in Fig. 1.[1]

[1] To provide a comparison, 4 cm of lead will stop around 90% of incident X rays generated by a 500 keV X ray generator.

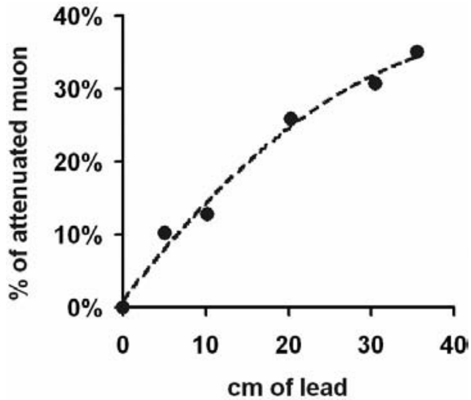

FIG. 1. Attenuation of sea level vertical muons in lead.

Such objects (of potential interest) may include lead lined vessels or other material transport modules. Because muons only show detectable interactions with high atomic number material, they also offer a means to detect the quantity and location of heavy metal elements and their associated compounds. Muon technology is also fully sustainable and safe as it relies on naturally occurring background radiation. Muon based imaging therefore opens up new possibilities to image the contents of shielded containers as well as chemical species identification by measuring the scattering angle of the incident muons. This paper describes the principles behind muon imaging and summarizes the experimental and technical development programme to date. The use of this developing technology to supplement and strengthen existing security measures at State port/border facilities may, in future, increase the overall ability of security forces to better detect incidents involving the illegal smuggling, disposal, possession, transfer and sale of nuclear and other radioactive materials by adversaries.

2. MUON SCIENCE

Since the discovery of cosmic rays in the 1940s, elementary particle muons have since become fascinating and exotic particles [2]. Primary cosmic ray particles, galactic or solar in origin, take the form of high energy (10^8–10^{20} eV) nuclear particles, electrons and photons, and continually bombard the Earth's atmosphere. These primary cosmic rays interact with nuclei in the Earth's atmosphere to produce secondary cosmic rays (pions, muons, electrons, neutrons and gamma rays) through high energy collisions [3]. High energy primary cosmic rays can produce a large number of secondary cosmic rays often forming an extensive shower. The primary components of the secondary cosmic radiation shower at sea level are muons, electrons, neutrons and gamma rays. Pions are unstable particles with a short lifetime of 26 ns and are rarely seen at sea level [4]. Although unstable, muons on the other hand have a much longer lifetime of 2.2 μs and are known to exist at sea level with an approximate flux of 160 particles $\cdot$ $m^{-2} \cdot s^{-1}$. Muons belong to the lepton family of particles, along with electrons, τ-particles and their corresponding neutrinos (ν_e, ν_m and ν_t) and interact with matter through both electromagnetic and weak interactions. Muons are unstable elementary particles and are sometimes referred to as 'heavy electrons' [5] with an unusual mass between a proton and an electron (1/9 m^p = 207 m^e). The variation in muon flux with respect to zenith angle is commonly assumed to follow a $\cos^2\Phi$ relationship due to attenuation effects in the Earth's atmosphere. To summarize, many more muons are seen approaching sea level from a vertical trajectory (zenith angle = 0) as compared to the horizontal (zenith angle = 90). The journey of the muon is summarized in Fig. 2.

3. PREVIOUS DEVELOPMENTS IN MUON TECHNOLOGY

Previous archaeological examples of muon enabled imaging include searching for hidden chambers in the pyramids of Egypt [6] and imaging the pyramids at Teotihuacans, Mexico City [7]. Some groups have attempted to use muon flux measurements for more geological based applications such as imaging the internal structure of a volcano [8]. More recently, a group at Los Alamos demonstrated that scattered muons recorded with a drift chamber array should be capable of detecting the presence of high-Z threat materials inside a large freight container in measurement times of a few minutes [9].

4. AIMS AND OBJECTIVES

The work described in this paper consists of three subwork packages, each of which is described in Sections 5, 6 and 7. The first work package was concerned with a theoretical 'proof of concept' provided by a Monte Carlo modelling approach to investigate the interactions of muons with various materials. Secondly, an experimental 'proof of concept' was undertaken in which a prototype muon camera was manufactured in order to obtain two dimensional muon flux and attenuation based images. The third and final work

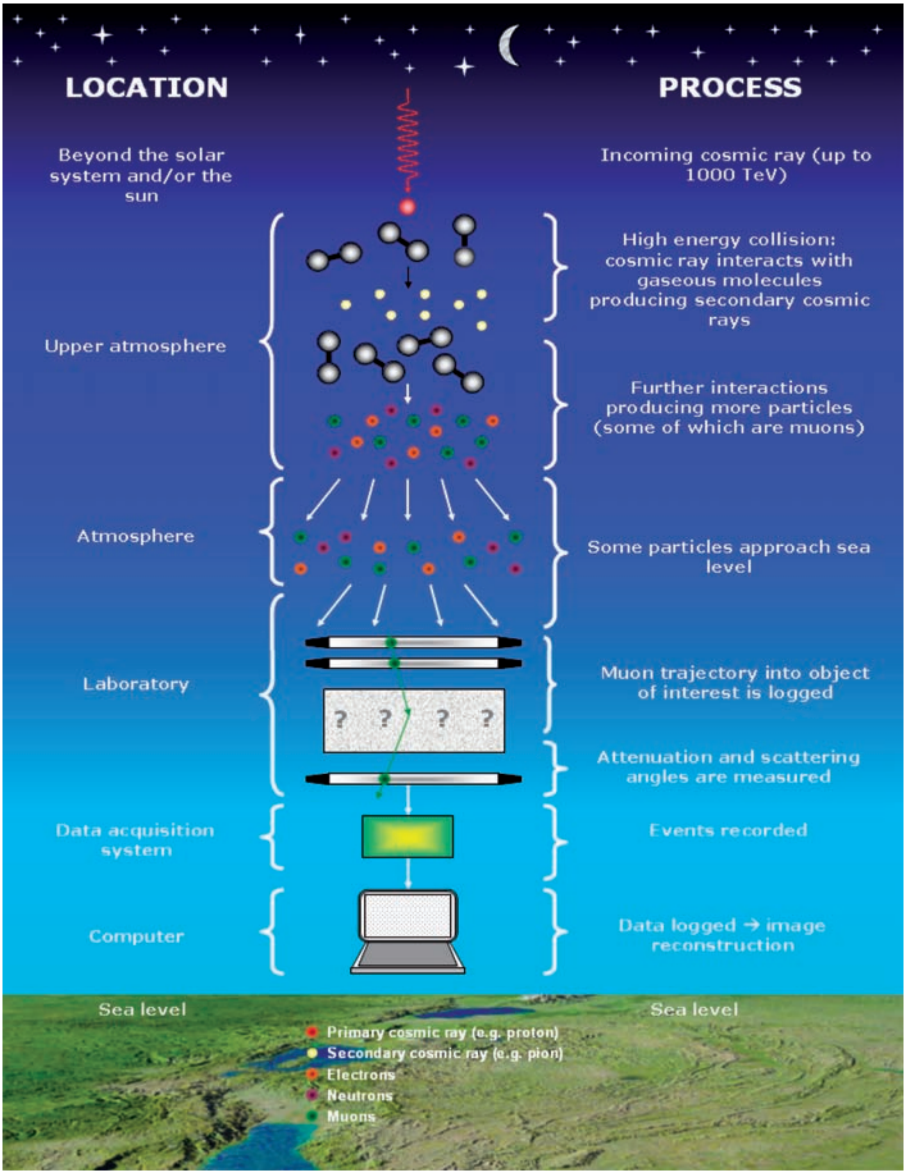

FIG. 2. The journey of the muon.

package built upon knowledge gained during work packages 1 and 2 and was specifically concerned with the provision of a detailed design for a commercially viable muon imaging system. The main drivers for the final system design include ease of deployability, cost and robustness as well as a much improved spatial resolution (~cm) to enable the measurement of muon scattering angle which may allow material discrimination.

5. MATERIAL DISCRIMINATION USING MONTE CARLO MODELLING

5.1. Introduction

At the time when the initial idea of using muons was formulated, the main potential application involved using (near) horizontal muons to image the contents of large storage vessels, although as the idea developed, the school of thought shifted to the utilization of vertical muons (which are much more abundant). The energies of horizontal cosmic ray muons are distributed largely between 0.1 and 1000 GeV with a mean energy of about 50 GeV. Radiation transport Monte Carlo methods (GEANT4) have been used to calculate the energy loss for a selection of industrial materials in the energy range of interest.

5.2. Monte Carlo simulations

The geometry shown in Fig. 3 was used to compare the use of energy loss techniques versus attenuation loss techniques using the GEANT4 radiation transportation Monte Carlo code [10].

The muons were transported through the geometry so that they arrive centrally on the face of Detector 1 and perpendicular to this face. The energy of the initial muon was taken to be 50 GeV to represent the mean energy of

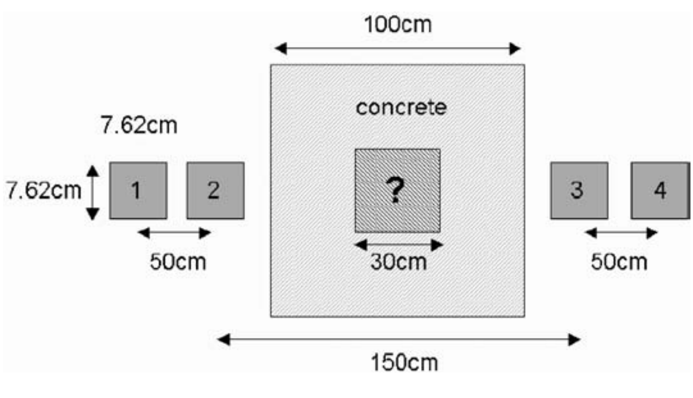

FIG. 3. Geometry used to compare the components of a fourfold telescope against energy loss measurements for the identification of materials.

horizontal muons. Each material that was to be tested was positioned in a 30 cm cube in the centre of a 1 m cube of concrete as well as a calibration measurement with no sample between the detectors. The test materials were concrete, air, iron, lead and uranium. Ten thousand muons were started for each material and measurements of the change in the energy of the muon across the sample were compared to the attenuation (by scatter or capture) losses in the fourfold coincident measurements (Table 1). The energy losses, however, allow material discrimination with only a handful of counts (Fig. 4), as the differences in deposited energy are so great. This implies that if the energy of the muon before and after the sample can be measured, the times needed per ray sum will fall to a few days.

5.3. Conclusions

The use of muon energy loss techniques in imaging of large vessels is a promising technique. The use of these highly penetrating but energetic particles means that large objects can be studied and large energies are also deposited in any detector system chosen. It has been shown that the use of simple attenuation of horizontal muons takes years to accumulate enough statistics to see differences in samples which are easily discernable with muon energy loss techniques using just a few muons. It should be noted that the muon energy employed in this initial study is the mean energy and the difficulty of the problem will be compounded with the naturally occurring horizontal muon energy distribution. It is also worth mentioning that the measurement of the muon energy before and after transmission through an object is not trivial. The detector resolution has to be such that the energy deposited in the detector by

TABLE 1. COMPARISON OF MONTE CARLO RESULTS FOR ATTENUATION LOSS AND ENERGY LOSS MEASUREMENTS

Sample	Fourfold coincidences (for 10 000 incident muons)	Mean dE/dx (GeV)
No sample	9985	0.0003
Air cavity	9984	0.294
All concrete	9986	0.478
Embedded iron	9975	0.865
Embedded lead	9971	1.171
Embedded uranium	9955	2.232

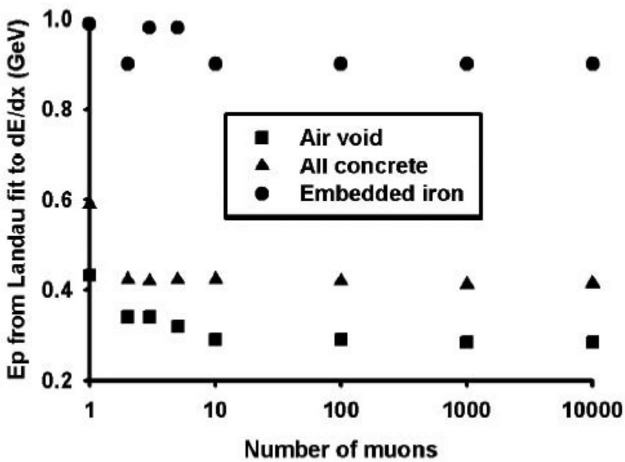

FIG. 4. Fit of dE/dx through different samples to a Landau distribution to determine the most probable energy versus number of muons used to produce dE/dx distribution.

the initial energy of the muon should be sufficiently different to the energy deposited in the detector by the exiting muon.

6. TWO DIMENSIONAL MUON BASED DENSITY MAPPING

6.1. Introduction

In order to attempt to image a given system using spatially varying muon flux measurements, a suitable means of determining the location of the muon event position in two dimensions is needed. The chosen method of muon detection relies upon scintillation; that is, the muon passes through the scintillator which produces a number of photons. These photons are then detected using photomultiplier tubes placed on the periphery of the scintillator. The photomultiplier tubes consist of a photocathode which emits electrons when subjected to incident photons (which is essentially the reverse of the photoelectric effect). These electrons are then multiplied by a charged dynode array as they cascade through the length of the photomultiplier tube. The output signal is measured as a voltage pulse (i.e. it has a peak voltage and a decay time). It is thought that comparing the response (peak voltage) of each photomultiplier will provide a means of determining the event position. To summarize, the muon detection relies firstly on the production of photons within the scintillator. These photons are then transmitted through the scintillator and onto the photomultipliers photocathode. Here, electrons are produced. This signal is then amplified using the charged dynode array to provide a measurable signal voltage.

6.2. Muon detector panel development

For this work, a square sodium iodide (NaI) scintillator block measuring 50 cm × 50 cm × 7.62 cm was used (Fig. 5). This scintillator block was placed within a 100 cm × 100 cm protective aluminium outer case. Scintillator panel clamps were used to hold the scintillator block in place. Each corner of the scintillator block was machined to allow the placement of the photomultipliers. Four Hamamatsu photomultipliers were placed in either corner. Clear flexible plastic was used to optically couple the photomultiplier tubes to the scintillator block. Scionix signal pre-amplification modules were used to steady the voltage gain settings, allowing cleaner signals. The photomultiplier tubes and pre-amps were held in place by a number of adjustable clamping mechanisms. The power supply and signal wiring were both terminated at a junction box on the outside edge of the panel. Four panels were manufactured.

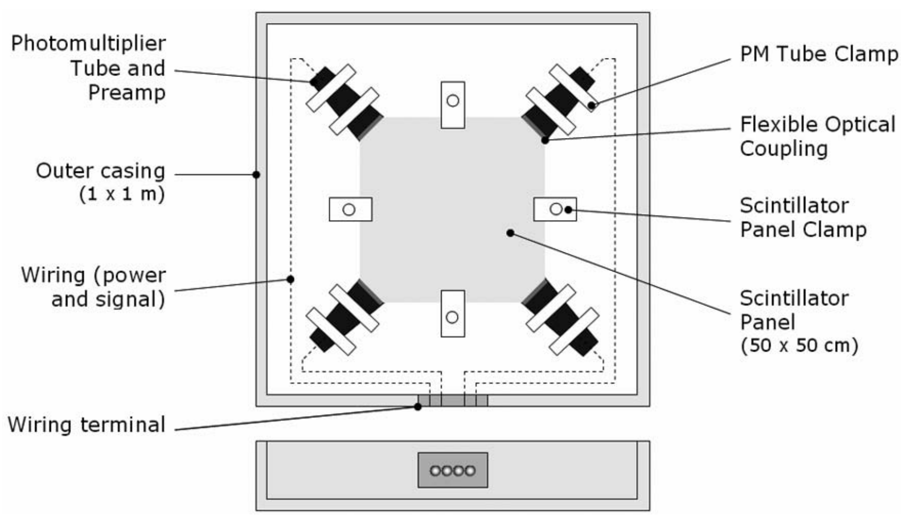

FIG. 5. Schematic representation of detector panel.

6.3. Detector panel calibration

An LED pulsed light source was assembled to undertake the panel calibration. This light source intrudes photons directly into the scintillator block through one of 81 access holes which were drilled in a square pattern in one quarter of the lid. The collimated light pulse could be placed in contact with the plastic scintillator via one of the access holes. Initially, the LED pulsed light source was introduced into the centre of the panel. The gain settings on the four peripheral photomultipliers were then set to give identical peak voltage signals. Once this had been achieved, the LED pulsed light source was moved to each of the boreholes in turn. This technique provided a full set of calibration data, in the form of 81 signal ratios, for any given (x, y) coordinate combination.

6.4. Two dimensional muon flux results

In the previous section, the optical pulse calibration technique was used to measure the photomultiplier responses for a given detector panel position. Subsequently, a 'look up table' method was used to obtain the most likely (x, y) event position. Two lead phantom arrangements were chosen. 15 cm of lead was positioned initially to cover the whole of the north-east and south-east quadrants in turn. Each experimental run described in this section was collected over a period of 5 h, although a period of 1 h should provide enough events to formulate a steady image. This yielded, on average, approximately 60 000 detectable events. An image reconstruction procedure was used to compute shown areas where a loss in muon flux was detected allowing the first muon flux based density measurements (Fig. 6).

6.5. Conclusions

Because of their superior penetrability, naturally occurring cosmic ray muons show great promise for imaging the contents of shielded containers used for illicit nuclear trafficking. A two dimensional muon flux based density mapping technique has been explored. An LED optical pulse method has been used to provide an (inferred) 81 point calibration of the detector panel. Measurable losses in the muon flux were detected in the lead phantom experiments. For the fully calibrated panel, the lead phantom position and thickness was successfully imaged, proving the technique is feasible.

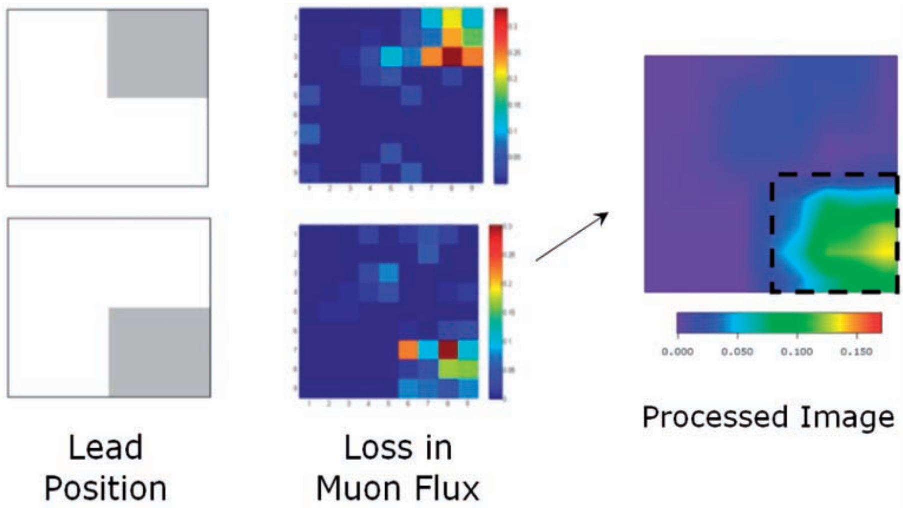

FIG. 6. Experimental layout showing lead phantoms covering the north-east and south-east corners, and the resultant changes in muon flux.

7. TOWARDS A COMMERCIALLY VIABLE AND DEPLOYABLE MUON IMAGING SYSTEM

7.1. Introduction

As mentioned previously, the third and final work package was concerned with the provision of a detailed design for a commercially viable muon imaging system. Because of pending patents, no technical details regarding the specifics are contained within this paper. However, the advantages and improvements associated with the new design are discussed in the following section. Also discussed in this section is the potential use of muon technology for the detection of illicit nuclear material.

7.2. Improved performance through smarter design

The prototype muon camera described in Section 6 provided a coarse and low resolution (~5 cm) muon based density map. Therefore, one of the main drivers for improving and developing the technology was concerned with improving the spatial resolution of the individual detector panels. The expected improvement in spatial resolution from the newly designed blueprint is expected to be significant (~1 cm). Also, the size of the new detector panels will be very different from the thick (~7.5 cm) and heavy panels associated with the prototype muon camera which has a rather restricted viewing window of 50 cm × 50 cm. Firstly, the thickness of the panels can be reduced significantly and is expected to be a fraction of that associated with the prototype camera, thus reducing cost while improving deployability. In addition, the size (viewing window) of the new panels can be significantly bigger than previously as they are much more efficient with regard to the detection of the generated light signal. Preliminary studies suggest a 20-fold increase in coverage area (as compared to the prototype camera) should be possible. Another significant improvement with the new panel design is their ability to be coupled together to enable a multiple panel approach. This modular approach should provide a means of computing images based on muon trajectories as compared to the previous geometrically unrestricted muon flux measurements. This can be achieved by using two or more panels above the volume of interest to detect the incident muon at two locations, thus providing the trajectory. A third panel beneath the volume of interest will provide a means to detect whether the incident muon emerges from the volume of interest, as summarized in Fig. 7.

Using multiple panels in this way will mean that only (near) vertical muons will be used to reconstruct an image as opposed to muons from other random trajectories. This multiple panel approach coupled with the improved spatial resolution previously mentioned may also provide a means to measure the scattering angle of a given incident muon, also shown graphically in Fig. 7.

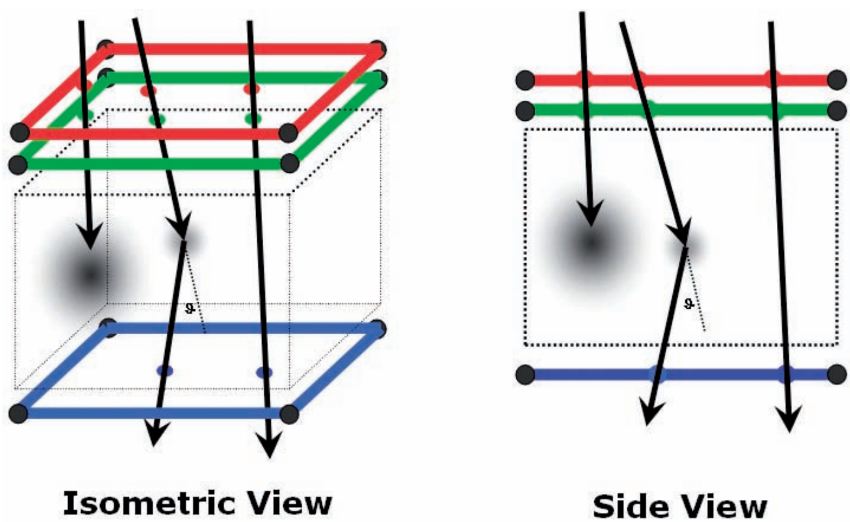

FIG. 7. Multiple panel approach for muon trajectory and scattering based imaging.

Because the muon scattering characteristics over a number of events depend on the interacting material, it is believed that this approach may offer a methodology for material discrimination/characterization (i.e. distinguishing lead from uranium from plutonium, etc.). Table 2 provides a summary of the advantages and improvements associated with the new panel design.

TABLE 2. COMPARISON OF PROTOTYPE MUON CAMERA AND THE NEWLY DESIGNED ALTERNATIVE

Criteria	Original prototype	New design
Spatial resolution	~5 cm	~1 cm
Panel thickness	~7.5 cm	~2 cm
Viewing window per panel	0.25 m^2	>10 m^2
Deployability/ transportability	Very heavy and cumbersome	Light, thin and can be rolled up
Imaging principle	Flux	Flux, trajectory and scattering angle
Estimated panel cost (£/m^2)	32 000	Estimated less than 8000
Material discrimination?	No	Potentially

7.3. Suitability of technology for the detection of illicit nuclear material

Because muons only show detectable interactions with very heavy materials (e.g. plutonium and uranium), muon scanners may be deployed specifically for the non-intrusive and remote detection of dirty bombs and/or nuclear material. Unlike conventional X ray imaging, which simply cannot penetrate very dense materials, muon technology has the ability to peer through these materials allowing the detection of nuclear material. Because muon technology uses freely available, naturally occurring cosmic radiation, there are none of the cost or safety concerns associated with using an external X ray source (exposing illegal immigrants to powerful X rays). In principle, this would involve a suspect vehicle moving between a number of muon detection panels (Fig. 8).

Most likely, this could be done off-line following a routine X ray interrogation where a specific region of the vehicle has been highlighted as suspicious. However, depending on the ability of the new panels to determine muon

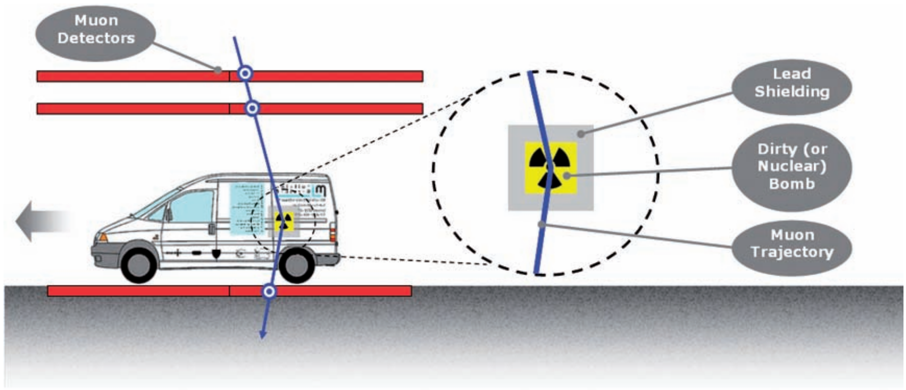

FIG. 8. Muon scattering enabled detection of illicit nuclear material.

scattering angle, a quicker on-line approach may be possible. However, for this to be successful, the suspect vehicle will have to be between the muon panels for the required time (i.e. to wait long enough for enough incident muons to formulate the desired quality of image). In real terms, this means that a vehicle may have to be stationary for a given time while the muon measurements are taken. For moving vehicles, an alternative approach to increasing the time the suspect vehicle is between the muon detector panels is to have longer panels. For example, if it takes 20 s to successfully image a stationary vehicle, approximately 80 m of detector panels would be required to image the same vehicle moving at 16 km/h to the same quality. Therefore, for a muon based imaging system to be able to image moving vehicles, longer sections of detector panels are needed, which in turn, requires that the panels are both cheap and modular in design, as with Nexia Solutions' new proposed design. However, a more realistic methodology to scan moving vehicles may be to use sections of panels (say much shorter than 80 m) to 'flag' a vehicle as 'suspect' with a view to undertaking a secondary off-line inspection where the vehicle is stationary.

8. CONCLUSIONS

Because of their superior penetrability, naturally occurring cosmic ray muons show great promise for the detection of shielded and concealed illicit nuclear material. During this work, muons have been detected and analysed using scintillation. In addition, the attenuation of muons in lead has been graphically presented. A prototype muon camera has been used to prove that two dimensional muon flux based density mapping is feasible by the computation of measurable losses in the muon flux for a number of lead phantom exposures. The design of a much improved modular muon detector panel has also been completed which offers significant benefits over the prototype such as improved spatial resolution, lighter, larger coverage area, cheaper, more deployable as well as the potential to measure muon scattering angles which may provide a means of characterizing different materials. It is believed that the aforementioned system may offer an economically viable means to detect concealed and shielded illicit nuclear material in suspect vehicles without the need for high voltage supplies and vacuum chambers as with other competing technologies.

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A SINGLE DETECTOR SPECTROMETRIC PORTAL MONITORING CONCEPT SOLVING THE PROBLEMS OF 'INNOCENT ALARMS'

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Abstract

In order to overcome the problems of 'innocent alarms' due to naturally occurring radioactive material (NORM) in vehicle monitoring and to medical isotopes in pedestrian monitoring, a new technology has been developed in the last few years, based on gamma spectrometry. The US Domestic Nuclear Detection Office (DNDO) has started a new approach to dynamic primary screening of vehicles, namely, advanced spectrometric portals (ASPs) based on multiple NaI scintillation or HPGe detectors. Complex and expensive instruments with up to 14 large volume NaI or HPGe detectors have been built and are presently being tested by DNDO. Up to now, it seems that these ASPs cannot meet the goal of detecting HEU masked by NORM 95% of the time. Even if this could be achieved, the approach is extremely expensive. The proposed new concept is based on a single detector spectrometric portal monitor (SRPM) with one large NaI crystal for dynamic primary screening of pedestrians, luggage, parcels, mail, etc., with immediate identification of innocent alarms. In addition, the SRPM can be used for secondary screening of vehicles in static mode after an alarm is triggered by a conventional plastic scintillator radiation portal monitor. After identification by the SRPM, the radiation source can be quickly localized with a highly sensitive gamma or neutron search detector, faster and easier as compared to a conventional radioisotope identifier device. One SRPM can serve several primary vehicle lanes for secondary inspection. This makes it even more economic. The paper describes test results obtained with a new SRPM, the SPIR IDENT, developed by SynOdys, France. Extensive testing, partly in cooperation with the IAEA, indicates that this instrument can meet the requirements of the IAEA, the International Electrotechnical Commission (IEC) and the American National Standards Institute (ANSI) for dynamic pedestrian monitoring as well as the IEC and ANSI requirements for static vehicle monitoring in secondary screening within a few minutes.

1. INTRODUCTION

'Innocent alarms' caused by naturally occurring radioactive material (NORM) in vehicle monitoring and by medical isotopes in pedestrian monitoring, turned out to be a serious problem for radiation portal monitors (RPMs). At present, most RPMs are based on plastic scintillation detectors which do not provide sufficient gamma energy resolution to identify the radionuclides. These monitors are used for dynamic primary screening of vehicles and pedestrians. In case of alarm, handheld radioisotope identifiers (RIDs) are needed for secondary screening to localize and identify the radioactive material, a laborious and time consuming procedure. Due to the limited sensitivity of the RIDs, the source can usually not be located and identified in vehicles or containers without unloading the freight. The intrinsic low neutron sensitivity makes RIDs practically useless for finding neutron sources which triggered an alarm in an RPM from outside the vehicle or container. The paper proposes a new concept to overcome these problems, based on single detector spectrometric portal monitors (SRPMs) and highly sensitive gamma and neutron search instruments.

2. INNOCENT ALARMS

The particular problem for truck and railroad monitoring, where large amounts of materials are transported, are frequent innocent alarms due to traces of NORM (or TENORM) present in many commodities. The most prominent radionuclides of NORM are ^{40}K, ^{238}U, ^{226}Ra and ^{232}Th. Typical goods causing NORM alarms are fertilizers, construction materials, granite, sand and rocks, ceramics, kitty litter, road salt, welding rods, polishing compounds, various fruits such as bananas, even marihuana (^{40}K), aircraft components or counter weights (DEU).

Impressive examples for serious problems with NORM alarms are the Piraeus Seaport, with more than 100 innocent NORM alarms every day for a total of five conventional vehicle RPMs or the Rotterdam Seaport, which in 2005 encountered a total of 2200 alarms for 875 000 passages with only 27 alarms not caused by NORM or medical isotopes [1]. This means that 99% of all the alarms were 'innocent'.

For pedestrian monitoring, when large crowds are checked, mainly at large airports or seaports, innocent alarms are frequently caused by medical radionuclides administered to patients for various diagnostic or therapeutic purposes. Approximately one in a thousand persons today receives medical isotopes which may trigger an alarm if the person passes a checkpoint even several days after the treatment. The most frequently used medical isotopes are ^{99m}Te, ^{201}Tl, ^{131}I, ^{111}In, ^{65}Ga and ^{18}F. For example, one single pedestrian monitor installed for test purposes at the Vienna International Airport registered 75 alarms in one month, 71 of them were medical, 2 NORM and 2 not identified, since the persons were not checked. A recent report by the US Domestic Nuclear Detection Office (DNDO) presented at a European Union seminar on border security in Brussels, Belgium, provides interesting statistical data for alarms triggered for about 1500 RPMs deployed early in 2007 in the USA. Of all alarms, 57% were caused by NORM, 16% were medical, 18% were legal shipments of radioisotopes, 4% were contaminated material and 5% were false alarms. This means that no alarm was caused by a real threat [2].

This information clearly shows that innocent alarms are the most serious limitation for current radiation border monitoring, which in extreme cases may render RPMs useless in practice. It has to be realized that in every such alarm situation, a laborious and time consuming secondary inspection procedure is required. The present routine starts with the verification of the alarm as real by a second independent measurement, followed by a cumbersome manual scanning procedure of the vehicle or container using a handheld RID. Only after location of the source, usually with unloading the truck or container, can it be identified and determined, whether it is an innocent or an illicit radioisotope.

3. ADVANCED SPECTROMETRIC PORTAL APPROACH

In order to overcome these problems, a new approach has been developed in the last few years, based on gamma spectrometry. While the common plastic scintillator detectors used to date for RPMs do not provide sufficient gamma energy resolution, NaI scintillation or HPGe detectors are able, in principle, to identify radionuclides based on gamma spectrometry. The US DNDO has launched a $1.2 billion programme to develop so-called advanced spectrometric portals (ASPs). In order to achieve the necessary sensitivity for dynamic primary screening of vehicles, multidetector instruments with up to 14 large volume NaI crystals or HPGe detectors have been designed and are presently being tested by DNDO at their Nevada test site. Up to now, it seems, however, that these ASPs cannot meet the expected requirements in practice. A recent report published by the US Government Accountability Office (GAO) shows that the detection rates of equipment tested were as low as 17% and the best ASP monitor could only identify masked HEU about 50% of the time [3]. In addition, this approach is extremely expensive — a single ASP costs about $377 000 — and may suffer from instability problems due to temperature drift under field conditions. It is doubtful that other countries apart from the USA will be able and willing to spend the enormous funds required for protecting multiple large border checkpoints with such expensive equipment.

The main technical problem and limitation of ASPs come from their use in dynamic primary screening of vehicles. This requires very fast measurement and data processing with a response time in the order of 1 s. Even with 14 detectors, each counting the radiation signal from the source plus its own background, the total number of counts accumulated after 1 s will generally be insufficient to provide the necessary statistics required for running a successful identification algorithm. The geometry of multidetector assemblies does not help in most cases, since the requirement for the search region of the RPM limits the variation of the count rate within the inspection area to less than ±50% anyway.

The only real alternative is to use spectrometric portals for secondary screening, which allows for a much longer measuring time. In practice, a duration of 300 to 600 s is not a problem for secondary inspection, since the vehicle has been separated from the main lane and therefore does not impede the traffic. In this case, a single detector would provide essentially the same statistical information as an ASP with 300–600 detectors of the same size — quite an unrealistic approach.

4. SINGLE DETECTOR SPECTROMETRIC PORTAL MONITORING CONCEPT

The proposed new single detector SRPM concept is shown schematically in Fig. 1.

The concept is based on a single detector SRPM with a large NaI crystal (2000 cm^3) for dynamic primary screening of pedestrians, luggage, parcels, mail, etc., with immediate identification of innocent alarms. In addition, the SRPM can be used for secondary screening of vehicles in static mode after an alarm is triggered by a conventional plastic scintillator RPM. After identification by the SRPM, the radiation source can be quickly localized with a highly sensitive gamma or neutron search detector. One SRPM can serve several primary vehicle lanes for secondary inspection. This makes it even more economic. Due to the much higher sensitivity and better identification software, SRPMs are generally able to provide identification faster as compared to RIDs, without the need for unloading vehicles or containers. Coarse localization can be achieved at the same time using the position of the maximum signal seen by the SRPM. Highly sensitive, handheld gamma search instruments are much more sensitive and cheaper compared to conventional RIDs. After neutron alarms

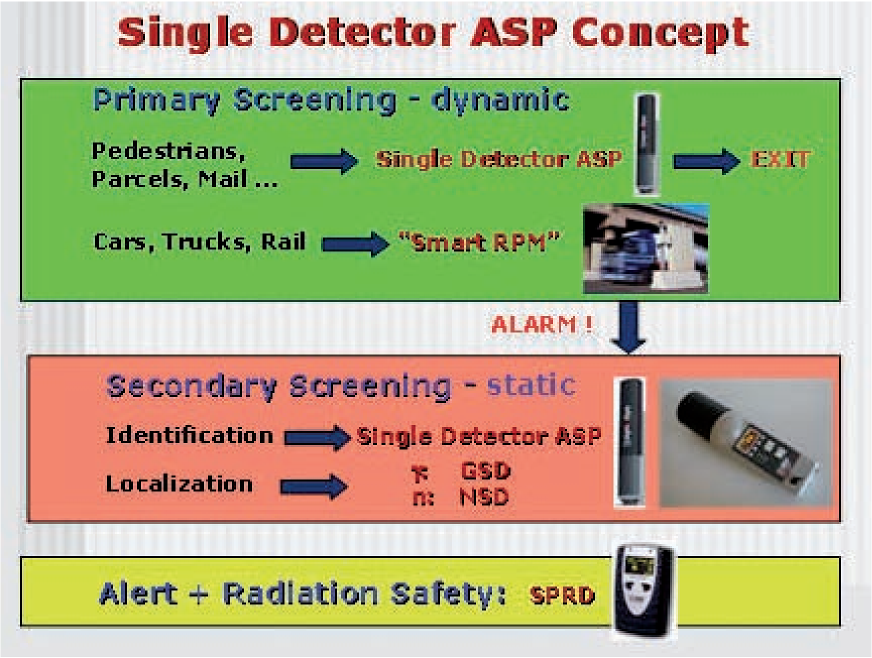

FIG. 1. The single detector spectrometric portal monitoring (SRPM) concept.

from an RPM, RIDs are mostly unable to find the source due to their very low neutron sensitivity. Handheld neutron search detectors, such as NSD-100 developed within a recent IAEA CRP and manufactured by the Scientific Engineering Center, Nuclear Physics Research, of ROSATOM in St. Petersburg, Russian Federation [4] are now available, with about 100 times higher neutron sensitivity than RIDs and at a much lower price.

Figure 2 explains the combination of two Smart RPMs with NORM suppression by 'windowing', such as RADOS RTM 910N, used for primary screening of two lanes, with one SRPM for secondary screening in static mode.

5. SINGLE DETECTOR SPECTROMETRIC PORTAL MONITOR SPIR IDENT

A new single detector SRPM, the SPIR IDENT, developed by MGP-SynOdys, France, has recently become available. Results of extensive testing, partly in cooperation with the IAEA Nuclear Security Laboratory, indicate that this

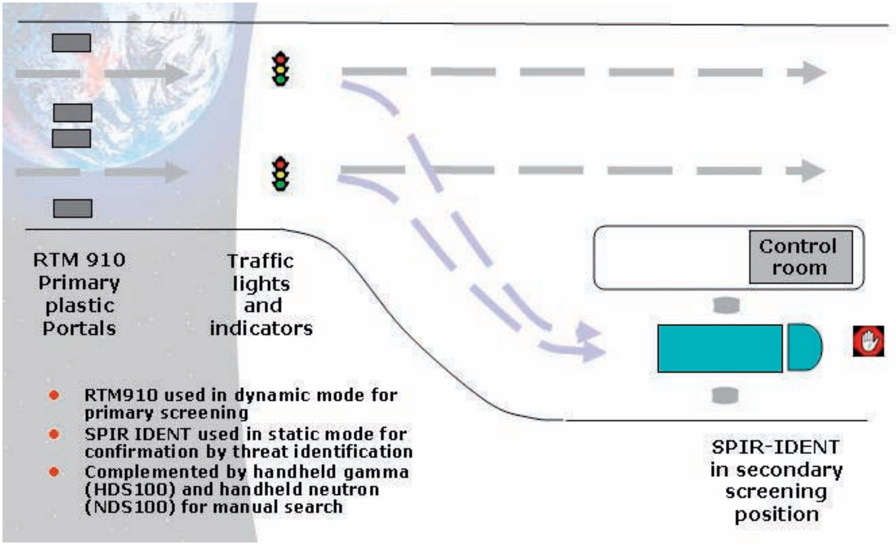

FIG. 2. Combination of two Smart RPMs with NORM suppression by 'windowing', such as RADOS RTM 910N, with one SRPM (SPIR-IDENT) for secondary screening in static mode.

instrument should be able to meet the requirments of the International Electrotechnical Commission (IEC) and the American National Standards Institute (ANSI) standards for dynamic primary screening of pedestrians and secondary screening of vehicles in static mode. SPIR IDENT consists of a slim pillar with a large NaI detector (2 in. × 4 in. × 16 in. (i.e. 5.08 cm × 10.16 cm × 40.64 cm), 2000 cm^3) with a fast MCA and embedded personal computer. The instrument is automatically stabilized on the ^{40}K peak of the environmental background with additional detector temperature compensation. The most important component, however, is the particular identification software, the SIA/IDENTPRO algorithm developed by Gunnink [5] in cooperation with the IAEA. The main features of SPIR IDENT are shown in Fig. 3.

The SIA/IDENTPRO identification algorithm is designed and optimized for:

— Quick identification with poor spectrum, poor statistics:
  - For detectors with poor or medium resolution (NaI, CZT);
— Method:
  - Measure peak areas by ROI method and fit isotopic response profiles in the 260–460 keV and 565–830 keV area;
  - Relate peak intensities to isotopes using the coefficients stored in interference matrix.

FIG. 3. SRPM SPIR IDENT and its main features: (i) detection, including true dose rate calculation, settable alert condition monitoring, and continuous background update and compensation; (ii) identification, including continuous spectra acquisition, continuous spectra stabilization, self or external triggered accumulation mode, and category, isotope and confidence level indication; (iii) local and/or remote signalling; (iv) automated alarm log.

The main performance criteria are:

— No detector calibration is needed, except for energy (automatically);
— No sample/source parameters are required;
— Fast response allows for short measurement and analysis time;
— Reliable identification (high ‘hit’ rate); low ‘false alarm’, particularly for U and Pu;
— Tolerant to variations of shielding and isotope masking;
— Able to analyse multi-isotope sources;
— Reports qualitative enrichment for U and burnup category for Pu.

Figure 4 shows a typical example of the spectra obtained with SPIR IDENT of a mixture of four radionuclides ^{57}Co + ^{60}Co + ^{133}Ba + ^{137}Cs within 10 s leading to total counts in the peaks of less than 50 counts, analysed by SIA/IDENTPRO. It can be seen that all four isotopes are clearly identified in spite of the poor statistics.

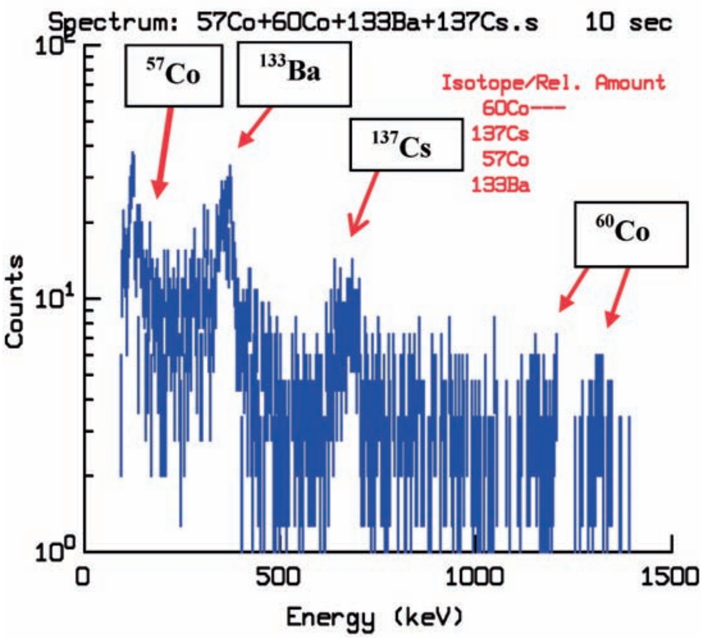

FIG. 4. Identification of a mixture of four radionuclides with poor statistics using the SIA/IDENTPRO algorithm.

A particularly important feature of the SIA/IDENTPRO algorithm is its ability to cope with masking of SNM by NORM or medical isotopes. In most cases, the software is able to resolve:

— Compton background and backscatter 'peak', e.g. for ^{137}Cs and ^{235}U or Pu;
— Intensity imbalance. The software greatly delays detection of the 'minor' isotope, e.g. for ^{57}Co plus ^{235}U;
— Isotopes with similar gamma energies and intensities, e.g. ^{131}I, ^{133}Ba and Pu;
— Distortion of spectra by shielding, especially with Pb.

Figure 5 shows the spectra obtained with a mixture of ^{133}Ba with Pu accumulated in a very short measuring time (10 s, 5–30 counts) and in 200 s, 100–800 counts.

Table 1 gives a comparison of the detection sensitivity of SPIR IDENT with various other instruments used for HLS radiation monitoring.

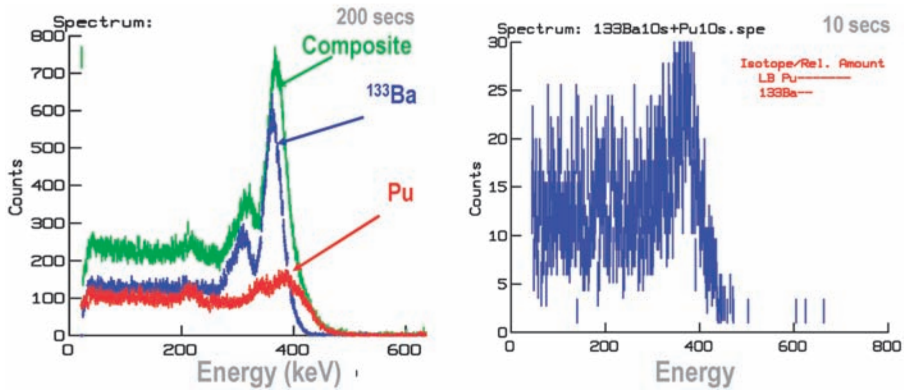

FIG. 5. Spectra obtained with a mixture of ^{133}Ba and Pu with poor and good statistics.

TABLE 1. COMPARISON OF DETECTION SENSITIVITY OF THE SPIR IDENT WITH OTHER INSTRUMENTS

Sensitivity comparison	Dosimeter	Survey meter	PRD pocket PDS100	γ-search handheld HDS100	SPIR-IDENT fixed	Pedestrian RPM [6]	Large RPM fixed PVC
Detector volume (L)				0.1	2		20
cps per 1 μSv/hr							
Typical background	0.03	1.70	15	150	1000		2500
^{241}Am	0.03	1.70	1000	13 000	250 000	78 000	650 000
^{133}Ba	0.03	1.70	750	5000	110 000	61 000	
^{137}Cs	0.03	1.70	250	1400	30 000	19 000	150 000
^{60}Co	0.03	1.70	90	600	15 000	9400	70 000

It can be seen that SPIR IDENT is considerably more sensitive than required for a pedestrian RPM in the IAEA publication, see Ref. [6].

6. RESULTS OF SPIR IDENT TESTS

The tests were performed according to Ref. [6] for primary screening of pedestrian monitors, IEC 62484 Spectroscopy Based Portal Monitors used for the Detection and Identification of Illicit Trafficking of Radioactive Material and ANSI N42.38 Performance Criteria for Spectroscopy-Based Portal Monitors used for Homeland Security for secondary screening of vehicles in static mode. In addition, SPIR IDENT is participating in the ongoing tests of SPRMs by the IAEA Nuclear Security Laboratory at Seibersdorf. The test results obtained so far indicate the capability of SPIR IDENT to identify the isotope of interest 'on-flight' within 1–2 s.

6.1. Dynamic tests as pedestrian RPM according to Ref. [6]

The false alarm tests resulted in less than 4×10^{-6} (required 10^{-4}), the search region tests in a count rate variation of less than ±15% (required ±50%). The static detection efficiency was 25 cps per nSv/h with ^{137}Cs (required 19), 76 with ^{133}Ba (61), 79 with ^{241}Am (78) and 14 with ^{60}Co (9). The tests for the dynamic detection efficiency resulted in 50 alarms in 50 passages with 1 MBq ^{137}Cs and ^{133}Ba at 1.5 m with a speed of 1.2 m/s (required >45 alarms in 50 passages). For every passage, the nuclide was properly identified. In addition, dynamic identification was performed for ^{40}K using 50 kg of fertilizer (60% K_2O) with a dose rate of 50 nSv/h, moving by with a speed of 1.5 m/s (Fig. 6).

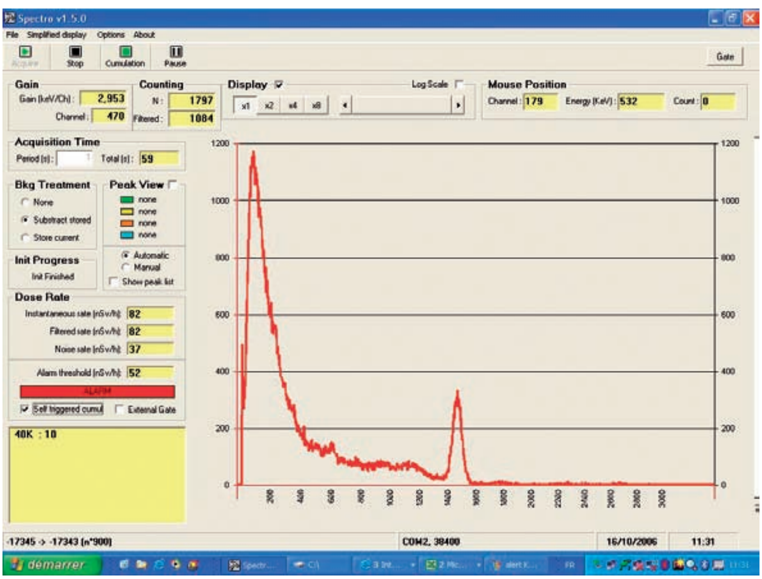

FIG. 6. Spectrum of ^{40}K alarm with dynamic identification displayed in 'expert mode'.

6.2. Static tests for secondary screening of vehicles according to ANSI N42.38

For secondary screening in static mode, compliance with ANSI N42.38 was achieved for the required nuclides and activities within a maximum time of 300 s (Table 2). With a single pillar SPIR IDENT, all requirements were met at a distance of 2.5 and 5 m from the sources, except for DU, where two pillars would be needed for the 5 m distance. In high background situations, dual pillars may be required.

7. CONCLUSIONS

Although improvements are still required, single detector SRPMs, such as SPIR IDENT, can in future provide a considerably better approach for HLS radiation monitoring compared to the present technology. Such instruments have the capability to solve the serious problems caused by innocent alarms due to NORM, medical isotopes or legal transports of radioactive materials. Using single detector SRPMs for dynamic primary screening of pedestrians, as well as for secondary screening of vehicles in static mode, complemented by highly sensitive gamma and neutron search detectors, will provide a better, faster and more economic solution for HLS radiation monitoring. SRPMs have the potential to eventually replace the time consuming and cumbersome searching and identification procedures required after an alarm of primary RPMs, based on today's handheld RIDs.

TABLE 2. COMPLIANCE WITH ANSI N42.38 IN STATIC MODE WITHIN 300 s

Natural background (20 nSv/h)		ANSI N42.38 compliance	
Isotope	Activity (μCi) (5 m)	2.5 m one pillar	5 m one pillar
^{241}Am	47	YES	YES
^{133}Ba(j)	9	YES	YES
^{60}Co	7	YES	YES
^{137}Cs	16	YES	YES
^{131}I	10	YES	YES
^{99m}Tc	16	YES	YES
^{232}Th	14	YES	YES
^{226}Ra	8	YES	YES
DU + 3mm Fe	4.5 kg	YES	NO

ACKNOWLEDGEMENTS

The author would like to thank F. Schulcz of MGP–Synodys, Lamanon, the principal designer of SPIR IDENT, for many fruitful discussions and M. Mayorov of the IAEA for the excellent cooperation during the ongoing SRPM test progamme at the IAEA Nuclear Security Laboratory, Seibersdorf.

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IAEA-CN-154/003

NETWORKED SOLUTIONS OF RADIATION CONTROL OF ILLICIT TRAFFICKING IN RADIOACTIVE AND NUCLEAR MATERIALS THROUGH STATE BORDERS

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Abstract

The radiation mobile Nuclear Protection Network system (NPNET™) was developed. The purpose of the system is to facilitate the investigation and decision making process in the case of detection of a radiation source. NPNET™ allows on-line data exchange between a user equipped with radiation detectors, e.g. spectroscopic personal radiation detectors (SPRDs) PM1703GNB, and a remote command centre. NPNET™ is recommended for use by border guards, customs, security and emergency services. The prevention of illicit trafficking in radioactive and nuclear materials as well as the dispersion of radioactive materials in urban areas is a challenging task of national security departments in many countries. To solve this task, appropriate actions of on-site personnel equipped with radiation detectors such as fixed radiation portal monitors or mobile personal radiation detectors are required. However, users of radiation equipment such as customs, border guards and police services often perform radiation control as an additional responsibility to their main duties. Furthermore, these users do not have sufficient expertise in radiation control and need real time remote expert help to interpret readings of radiation equipment and expert support in the decision making process.

Polimaster has developed a total solution called the Nuclear Protection Network system (NPNET™) for highly effective radiation control at State borders as well as inside a country. NPNET™ is intended for efficient interaction and on-line data exchange between a user's radiation control instrument, for example, a personal radiation detector or identifier, and a command centre. The availability of such a system allows one to more efficiently solve tasks of detection, localization and identification of ionizing radiation sources, to properly interpret false alarms (e.g. detention of a passenger having had radiotherapy) and to effectively prevent illicit trafficking of radioactive and nuclear materials.

The radiation mobile system NPNET™ is a two level system:

(1) The lower level consists of fixed radiation portal monitors PM5000A located at different customs checkpoints and a number of user groups equipped with gamma or gamma–neutron spectroscopic personal radiation detectors (SPRDs) PM1703MB/PM1703GNB or PM1401MB/PM1401GNB models (Fig. 1). The most outstanding feature of these SPRDs, besides their radioactive source detection and localization functions, is their ability to accumulate the gamma spectrum of a radioactive source and transfer it through the Bluetooth channel to a pocket PC (PDA) for further data processing. Moreover, the PDA is provided with a global positioning module GPS, that allows on-line tracking of user location. As depicted in Fig. 2, information on the radiation environment and user location is transferred through wireless communication to the upper level — the level of the command centre or expert group;

(2) The upper level is a remote command centre or expert group that performs continuous monitoring of radiation portal monitor status and mobile user locations, their routes and radiation background level along the whole route (Fig. 3). If the level exceeds background radiation level due to radioactive source detection, an expert immediately receives an 'alarm' notice from the instrument and information about the source location. If the SPRD is used, the expert additionally has access to

FIG. 1. Networked gamma–neutron portal monitors PM5000A and spectroscopic personal radiation detector PM1703GNB with a pocket personal computer.

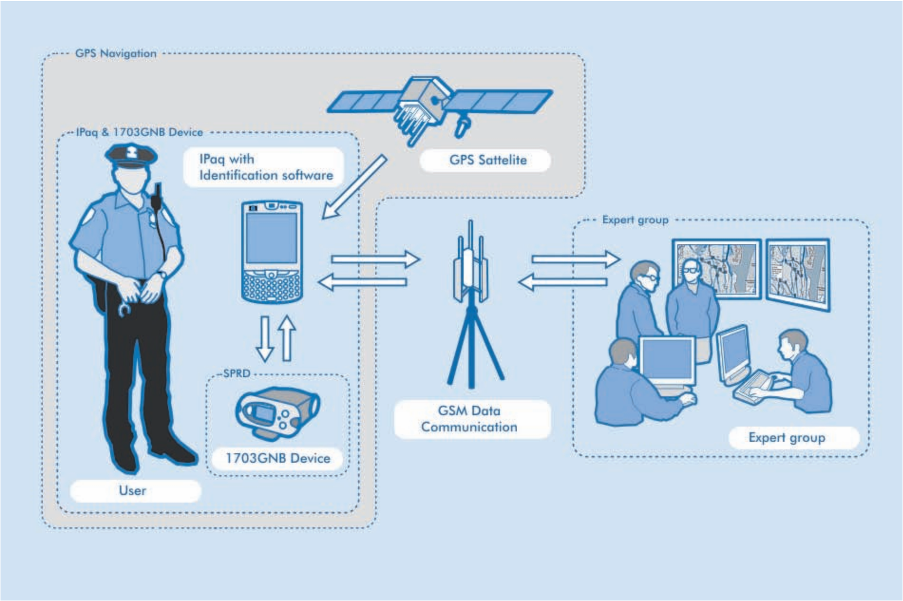

FIG. 2. General view of data transfer from SPRD PM1703GNB to the remote command centre or expert groups.

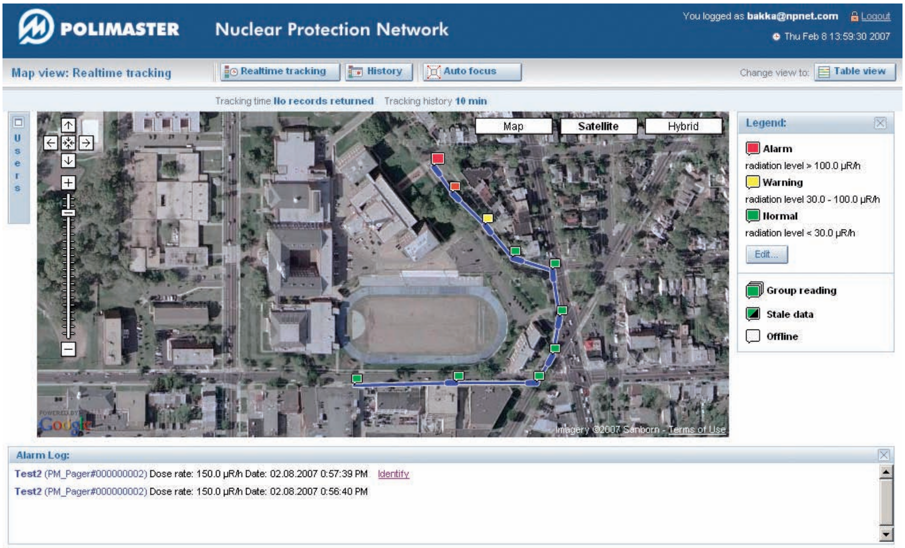

FIG. 3. On-line tracking of mobile user locations and radiation background level along their routes.

measured dose rate value and the file with a gamma source spectrum for the purpose of independent identification. With the help of the radiation mobile system NPNET™, the expert group is able to manage the process of investigation of radioactive source detection on-line.

NPNET™ can cover territory as large as a city or even a State and provides assistance to an infinite number of independent user groups. NPNET™ has a modular structure and could be easily adapted to any specific user's requirements. Thus, the radiation mobile system NPNET™ is an effective tool for the prevention of illicit trafficking of nuclear and radioactive materials, and is recommended for use by border guards, customs, and security and emergency services.

IAEA-CN-154/005

A FISSILE MATERIAL DETECTION AND CONTROL FACILITY WITH PULSED NEUTRON SOURCES AND DIGITAL DATA PROCESSING

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Abstract

A physical method has been developed for the detection of fissile and radioactive materials in models of customs facilities with a graphite moderator, pulsed neutron source and digital processing of responses from scintillation PSD detectors. The ability to detect fissile materials, even those shielded with various radiation absorbing screens, has been shown. The parameters of the protection providing the radiation safety of the facility have been determined.

1. INTRODUCTION

In connection with possible nuclear terrorism, there has been a long felt need of devices for effective control of radioactive and fissile materials (FM) at the key points of crossing State borders (airports, seaports, etc.), as well as various customs checkpoints. The most hazardous are ^{235}U and ^{239}Pu, as they are the basic components of nuclear weapons. In addition, terrorists might make a 'dirty' atomic bomb (e.g. one dispersing various fissile nuclides), the explosion of which would result in the contamination of large territories. This would cause enormous numbers of victims and would require tremendous funds for rehabilitation of the habitat (especially in the case of an explosion in an urban area).

2. FM DETECTION AND CONTROL FACILITY

2.1. Description of the facility

In ISTC Projects Nos 596 and 2978, a new physical method and digital technology were developed for fissile and radioactive material detection in models of facilities with a graphite moderator and a pulsed neutron source [1]. The use of digital processing of scintillation signals in this facility is a necessary element, as neutrons and photons are discriminated by the time dependence of FM responses at such loads on the electronic channels that standard types of spectrometers are inapplicable. Digital processing of neutron and photon responses practically resolves the problem of dead time and allows the creation of unified data acquisition systems that require no time analysers, coincidence circuits or spectrometer devices. This considerably reduces the assortment of electronic units, and allows the use of physical methods of FM detection and control previously inapplicable for such purposes. This approach allows implementing devices, in which various energy groups of neutrons exist for some time after a pulse of source neutrons. Thus, it is possible to detect FM deliberately concealed with shields having a large cross-section of absorption of photons and thermal neutrons.

Calculations using the code MCNP-4c2 have shown that cadmium shielded FM can be detected in the facility with a high atomic number moderator. Therefore, a model of a customs facility with a graphite neutron moderator has been created, in which, according to the calculations, cadmium shielded uranium can be detected during the first 150 μs after the pulse of source neutrons. During this time interval, the facility contains slowing down epithermal neutrons from the source that are poorly absorbed in lead and cadmium shields. The facility represents a graphite parallelepiped 1300 mm × 1300 mm × 1200 mm in size with an air cavity inside, which simulates the baggage chamber that is 550 mm × 650 mm × 1200 mm in size. The model of the customs facility used for the measurements is shown in Fig. 1. In the experiments, DT and DD neutron generators with a neutron yield of ~10^8 n/s were used. All the generators were designed and manufactured at the Institute of Automatics (VNIIA), Moscow, Russian Federation. As detectors of fission neutrons and photons, a stilbene crystal of Ø 40 mm × 40 mm or an LS-13-type liquid scintillator of Ø 65 mm × 180 mm (manufactured by Amcrys Ltd, Ukraine) were used. The system of scintillation detectors was created by the RIPT, Moscow, Russian Federation.

2.2. Experimental results

A representative series of experiments was carried out with FM samples of different mass and ^{235}U enrichment, as well as with samples surrounded with cadmium, lead and composite (lead, cadmium, plexiglas) shields. The ^{235}U enrichment of the samples varied from natural up to 90%, and the mass from 8 to 132 g. The primary criterion of FM detection in the facility is fast fission neutrons that can be detected, when PSD scintillators discriminate the FM

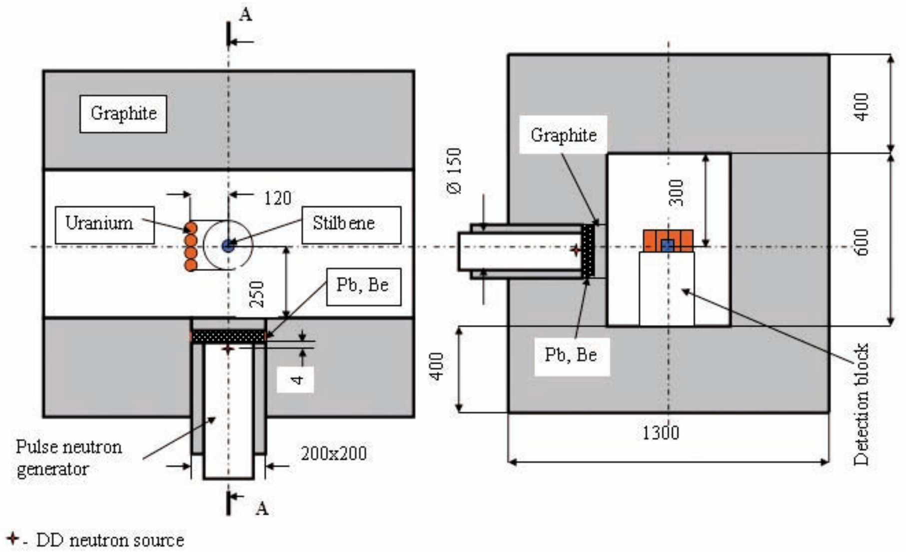

FIG. 1. Schematic representation of the model FM detection facility with a graphite moderator and inserts of different materials and sizes.

response into the photon and neutron responses with use of digital technology during the time after the pulse of fast neutrons from the source. Figure 2 shows the experimental results obtained at digital discrimination of time responses of neutrons and photons occurring in the fission of uranium samples without radiation absorbing shields, as well as with a composite shield made of 50 mm thick lead and 1 mm thick cadmium. One can see that the fission neutron

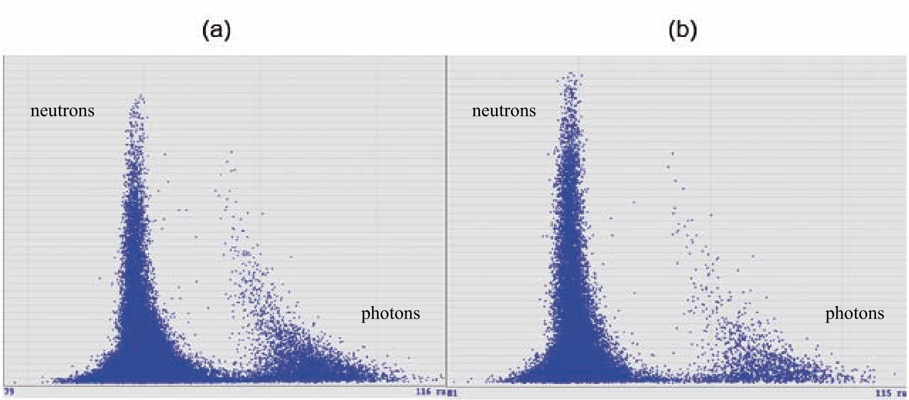

FIG. 2. Measurement with (a) non-shielded uranium; and (b) uranium shielded with lead and cadmium.

response is visible in both cases and is sufficiently well discriminated from the response of photons. The results of these experiments have shown that all uranium samples including those in cadmium and composite shields were detected with a sufficient degree of reliability.

2.3. Computational studies

When the facility is operated in passive mode, even plutonium isotopes can be detected by the spontaneous fission response, and ^{235}U and ^{239}Pu by their natural photon emission [1], and also any radioactive materials can be identified by their photon spectrum. Calculations were performed to investigate the effect of beryllium and lead inserts located in front of the neutron generator target on the total number of fissions of uranium samples with a total mass of ^{235}U of 132 g. Typical results of the calculations are presented in Fig. 3. One can see that the time behaviour of the FM neutron response with and without the presence of cadmium essentially differs. An

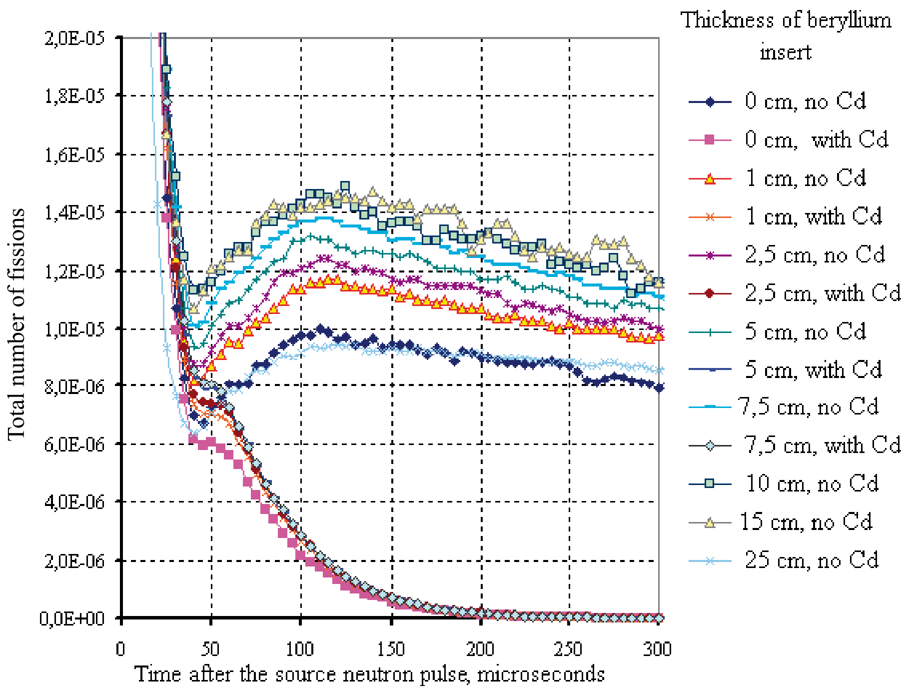

FIG. 3. Total number of fissions in four uranium samples shielded with cadmium and without shields in the facility with a graphite neutron moderator at various thicknesses of the beryllium insert as a function of time after the source neutron pulse.

analysis of the calculation data shows that it is very important to be able to discriminate well neutron and photon responses at short times after the pulse of neutrons from the source. The reason is that at short times after the source neutron pulse, the response of fission neutrons of a cadmium shielded sample rose considerably. Therefore, in ~30 μs the number of fission neutrons, in the presence of a cadmium shield, decreases by a factor of approximately 20–30 compared to the absence of a cadmium shield. At 5–20 μs, the neutron responses of cadmium shielded FM and non-shielded FM practically do not differ.

2.4. Calculation of the radiation safety of the facility

The use of a neutron generator as a neutron source in the customs facility for the detection of FM in passengers' baggage results in the formation of neutron and photon fields near the facility, the dose characteristics of which considerably exceed the allowable levels. This requires constructing a radiation protection area that would provide safe conditions for personnel and passengers.

A series of multivariate calculations has been carried out for the protection to provide radiation safety around the customs facility with a multi-channel scintillation system for the detection of FM responses. The facility contained 20 independent channels of detection of neutrons and photons with PSD scintillators of Ø 65 mm × 180 mm. The arrangement of the detectors in the facility is shown in Fig. 4. In each scintillation channel, a board for digital processing of FM responses working in real time is installed.

Estimate calculations of the biological protection used the following initial data:

- The maximum permissible exposure dose (MPE) according to the radiation safety standards NRB-99 was accepted as 20 mSv/a for a working time of 1700 h/a for personnel;
- The MPE for passengers was accepted as 1 mSv/a for the time of a passenger's presence in the baggage collection areas of 20 min;
- The calculation of the biological protection used a coverage factor of two;
- The stationary operation of the neutron source was considered, with a yield of neutrons equal to 10^8 n/s;
- Isotropic angular distribution was supposed for neutrons of sources with energies of 14.7 and 2.5 MeV depending on the generator type;
- The effective doses of external irradiation at separate points of the customs facility composition were used as the dose characteristics of the radiation fields (see Fig. 4).

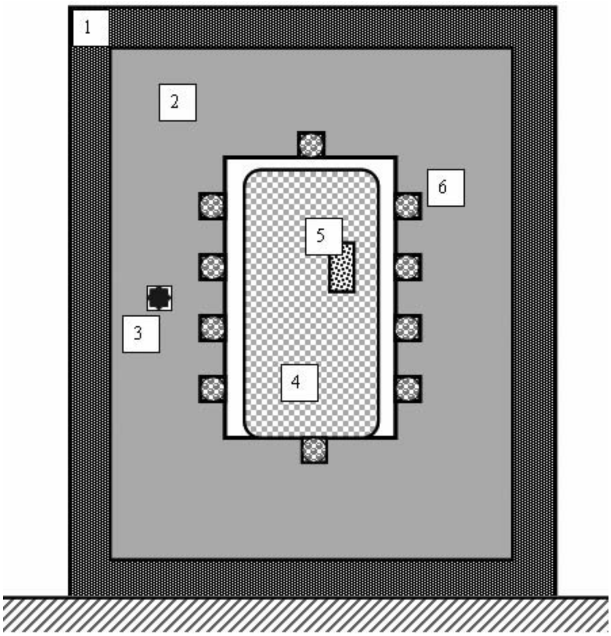

FIG. 4. Schematic representation of the prototype of the facility for the detection of FM in passengers' baggage: (1) shield; (2) graphite; (3) neutron generator; (4) baggage; (5) FM; (6) liquid scintillates.

From the initial data, one can derive that the permissible effective dose rate of passengers should not exceed 55 × 10^{-9} Sv/s, and the permissible dose rate of the personnel is equal to 1.63 × 10^{-9} Sv/s. Thus, the parameters of the biological protection should be determined by the permissible dose for the personnel.

Multivariate calculations of dose fields along the external perimeter of the facility performed for the use of borated polyethylene, steel and boron carbide as shielding materials have allowed suggesting a variant of protective structure shown in Fig. 4.

In the calculated variant of the customs facility, at all considered points behind the protection, the total effective dose rate of neutrons and secondary photons does not exceed the permissible values, when a 2.5 MeV source is used. The contributions to the dose of neutrons and secondary photons at the majority of calculation points are approximately equal. Taking into account the small thickness of protection, it seems unreasonable to shape it due to design considerations.

3. CONCLUSIONS

The complex calculations and experimental studies performed allow a real customs FM detection facility operated at airports to prove the following key parameters:

— Detection of any radioactive materials with determination of their type;
— Detection of ~5–10 g of ^{235}U or ^{239}Pu in 5–7 s;
— Impossibility of deliberate FM concealment with radiation absorbing shields, for example, lead or cadmium shields;
— Use of a pulsed DD neutron source with a yield of ~7×10^7 n/s;
— Impossibility of contamination of airport premises, even in the case of deliberate destruction of the neutron source (act of terrorism);
— Complete safety of the neutron source during its downtime or transport;
— Implementation of a universal system of experimental data storage and processing suitable for repeated processing of the obtained data;
— Considerable reduction of the assortment of electronic units, which decreases the total cost of manufacture of the facilities;
— Use of high performance, fast digital scintillation systems for the discrimination of neutrons and photons, working in real time under loads on the electronic channels up to 5×10^5 particles/s;
— Basic dimensions of the full scale customs facility:
  - Baggage chamber: 550 mm × 750 mm × 1000 mm;
  - Facility without radiation protection: 1350 mm × 1550 mm × 1200 mm;
  - Facility with radiation protection: 1470 mm × 1670 mm × 1380 mm.

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DISCUSSION

SESSION 7: New Technologies — I

R. ARLT (IAEA): (1) I. Thompson, how far away are we from establishing International Electrotechnical Commission (IEC) standards that will then serve as a basis for equipment acceptance in Europe? (2) V. Romodanov, what is the size and weight of your portable neutron generator? Have you compared the sensitivity of your method with that of any other methods using active neutrons in the sensitivity limits as a function of measurement time for nuclear material?

I. THOMPSON (International Electrotechnical Commission): (1) The European Committee for Electrotechnical Standardization (CENELEC) is investigating whether they should adopt all of the Subcommittee 45B standards, so that it covers measurement of airborne contamination — the whole range of radiation protection instrumentation. At the moment, IEC 62327 and 62244 — related to illicit trafficking — are under study by CENELEC and should be adopted as European standards in about a year. CENELEC can only adopt published IEC standards, so IEC 62401 and the personal radiation detectors (PRDs) already published should be the next CENELEC priority. Other IEC standards listed in my presentation will be published within the next two years.

V. ROMODANOV (Russian Federation): (2) As to the sensitivity of our method, tests showed that the measurement time was approximately 3 s; the output of the neutron generator was 10^7 n/s. I estimate that the sensitivity of all methods is about the same.

B. WARREN (United Kingdom): Could S. Abousahl comment on the release dose levels at hospitals across the European Union and, if possible, globally? How uniform are they (i.e. is a system in place or under development)?

M. MAYOROV (IAEA): The results of tests of spectroscopic portal radiation monitors were provided by the IAEA but the regulation data were provided by K. Duftschmid and they refer to the Austrian national standards.

SESSION 7: New Technologies — II

R. GUYONNET (France): Since the issue of discrimination (e.g. between lead and other nuclear material) is very important for operational purposes, my question is about physical limitations you might encounter: (1) Do you know the scattering cross-sections with a significant level of precision? (2) Do you expect very different scattering angles in high Z material, especially when only a small amount of nuclear material is present?

S.J. STANLEY (United Kingdom): The main limitation to discrimination accuracy is the time, and how many muons interact with the material. (1) The scattering angles are distributed for a given system. Therefore, the more measurements taken, the more accurate the estimation of the material's atomic number will be. (2) There will be a limitation with regard to the size of the detectable material. We have not investigated this experimentally.

W. GELLETLY (United Kingdom): S. Stanley, (1) how large a system can you deploy? (2) Could you detect fissionable material by adding neutron detectors to detect neutrons from muon induced fission?

S.J. STANLEY (United Kingdom): This depends on the detector design and the temporal density of data. The prototype was small because of the limited optical transmission efficiency. We hope that 10 m^2 will be achieved next time. (2) I am not sure but I do not see why not.

POSTER SESSIONS

IAEA-CN-154/002P

FRAMEWORK FOR IMPROVING THE NATIONAL SYSTEM AND CAPABILITIES IN COMBATING ILLICIT TRAFFICKING OF NUCLEAR AND OTHER RADIOACTIVE MATERIAL IN SERBIA

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Abstract

Situated in a sensitive, vulnerable and easily affected region of the Balkans, Serbia is a country with an important geostrategic position which is passing through a period of a State, political and economic transition. A well organized and controlled State system of peaceful use of nuclear energy during the period of the former Yugoslavia now only exists in some domains and functions in a fragmented way. Crises and historic changes in the country, as well as a gap in international cooperation in the last decade, have influenced the State's capabilities to manage this field and have imposed a need for a new start in line with updated global directions, in particular, where nuclear security is concerned. A delicate process of nuclear decommissioning in the Vinca Institute which comprises spent nuclear fuel stored in a bad condition for shipment to the country of origin, safe waste management and decommissioning of the research reactor, together with 50 years of piled up historic waste from the whole former country stored in bad condition, as well as other, not yet solved, complex issues, which are a legacy of the past, capture the greatest attention and funds in a country which is passing through the process of State stabilization and building of institutions after a period of isolation. Realizing the importance of strengthening nuclear security, the Serbian authorities are making efforts to lay a basis for a well founded nuclear security system and improved national capabilities for combating illicit trafficking through introducing integrated border control at the border crossing points with eight neighbouring countries. With the support of both international and domestic assistance, and earlier gained knowledge and capacities, this is progressing gradually but steadily. Implementation of international legal instruments, and the IAEA and other international soft law recommendations and standards, and their translation into national legislation, are understood as being a precondition for further progress and as grounds for a modern statutory framework, and well conducted national and international coordination and cooperation aimed at setting up an effective national nuclear security system with all the relevant authorities and actors engaged. The significance of having an efficient and workable system in

place, with a developed network, procedures and defined responsibilities, in particular, in the countries with a sensitive position and internal state, as is the case in Serbia, has been increased nowadays, when global efforts for suppression of acts of nuclear terrorism and combating illicit trafficking are of the utmost interest for the whole international community.

1. BACKGROUND AND POSITION IN INTERNATIONAL RELATIONS IN THE NUCLEAR FIELD_

1.1. Background

Serbia is in a period of economic transition, State capacity building and restoration/establishment of national systems in many sectors. That also relates to overall international cooperation. It includes cooperation with the IAEA, which is constantly increasing and improving. Although it is not a nuclear power plant country (the law banning the construction of nuclear power plants of the former Yugoslavia is still in force — Official Gazette SRY 12/95), a significant nuclear component, together with the full scope of radiation related issues, determines the nuclear infrastructure of the country. The nuclear infrastructure of Serbia, once well managed and with a highly professional staff, has deteriorated over the years. It comprises a number of facilities, institutes and organizations, creating a framework for the issues requiring attention. The IAEA carries out its safeguards inspections in the Vinca Institute of Nuclear Sciences on a regular basis, and the country receives IAEA technical and other assistance which is indispensable for further regulation and improvement in the nuclear field with a defined role of use of nuclear energy only for peaceful purposes and for the benefit of civil society.

1.2. Position in international relations in the nuclear field

During the 1990s, Serbia passed through a difficult period in all areas of political, economic and social development. Its international activities were limited to a minimum until the sanctions imposed by the United Nations in 1992 were lifted after the political changes. The country regained United Nations membership in November 2000 (United Nations Resolution A/RES/55/12). After the State union of Serbia and Montenegro fell apart in 2006, Serbia succeeded the rights and obligations coming from its memberships in intergovernmental organizations, including the IAEA. Since 2000, the country has participated in a wide spectrum of activities of the IAEA's programmes. International cooperation has become an essential factor in capacity building in the nuclear area and in the integration of international recommendations into national practice. This also relates to the field of nuclear security.

Although it is not yet a member of the European Atomic Energy Community (Euratom), membership of the European Union is the top strategic priority of the Government of Serbia which assumes integration of European Union and IAEA standards into national legislation. Serbia is also not a member of the Nuclear Energy Agency of the Organisation for Economic Co-operation and Development (OECD/NEA). It is, however, a member of the Organization for Security and Co-operation in Europe (OSCE), the United Nations Office on Drugs and Crime (UNODC), the World Customs Organization (WCO), INTERPOL, the Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO), the World Health Organization (WHO), the World Metereological Organization (WMO) and the United Nations Environment Programme (UNEP), etc. Through membership of these intergovernmental organizations and their inter-relations, the coordination of cooperation in the field of nuclear security and, in particular, in combating illicit trafficking, as a cross-cutting area, is being facilitated and enhanced in border monitoring, continued interaction in legislative matters and seeking synergies for assistance on various issues.

2. NUCLEAR CAPACITIES AND INFRASTRUCTURE

A full spectrum programme of nuclear energy application for peaceful purposes, from nuclear power generation and research reactors to isotope applications was carried out in the former Yugoslavia. It was conducted under the control of the then Federal Commission for Nuclear Energy. A substantial part of that programme was implemented within the territory of Serbia and a high level of national experience and expertise was reached in nuclear technology, nuclear science and practical applications.

In spite of the constant deterioration of nuclear capacities over the years, there are still considerable nuclear facilities, material and capacities and significant, although reduced, professional knowledge and human resources, in particular, in the Serbian Vinca Institute of Nuclear Sciences. As the first of the six nuclear institutes in the former Yugoslavia, it was founded for research and application in nuclear sciences in 1948 (since 1968, it has also been involved in various multidisciplinary activities). The institute covers a wide range of fields in physics, engineering, radiation and environmental protection, nuclear engineering and research. Nuclear facilities, materials, activities and services in Serbia are, for the most part, performed or situated in this institute which is still a respected organization, not only nationally but also internationally.

Two of the three research reactors from the former Yugoslavia, namely, RA — a 6.5 MW RR in decommissioning and RB — a zero power heavy water research reactor commissioned in 1958; two middle and low radioactive waste storages in bad condition with 50 years of piled up waste from the entire former Yugoslavia (including its six republics); the productive uranium mine at Kalna; a considerable amount of spent nuclear fuel from the RA nuclear research reactor; a complex problem to be solved in shipping the fuel to the country of origin; more than 2500 radiation sources in medicine (including dental); and 250 industrial sources, together with the network of institutions and services, make Serbia a country which still draws international attention where nuclear issues are concerned. The process of completing a nuclear martial and radioactive sources inventory is under way.

Although a specifically defined nuclear programme has not yet been enacted, the strategy of development is determined by the scope and type of activities, capacities and infrastructure. It has been verified by several decisions of the Government and financially supported from national funds. They reflect a commitment of the Government towards nuclear decommissioning in the largest Serbian institute, the Vinca Institute Nuclear Decommissioning (VIND) programme, which, due to its challenging complexity, attracts major funding and attention. It has been accepted, and nationally and internationally supported since 2003. The main objective is to solve existing radiation and nuclear safety problems that are a consequence of peaceful uses of nuclear energy in the former Yugoslavia since 1955 and comprises:

— Shipment of spent nuclear fuel from the RA research reactor back to the country of fresh fuel origin — the primary and most urgent task, due to the leakage of fission products detected and a serious threat to the environment. It is a complex task which includes spent fuel element preparation, repackaging, safe transport and reprocessing;
— Low and intermediate radioactive waste (RAW) management at the site of the institute. Construction of a new and safe RAW temporary storage facility (‘H3’) and a waste processing facility by the end of 2008 will enable the institute to receive new RAW generated in the future, mainly from dismantling RA, historical RAW during decommissioning of the old storage facility (‘H1’) and RAW from various organizations from the country which are using radioactive sources and materials;
— Decommissioning of the RA research reactor will provide for safe and cost effective removal and storage of all radioactive components of the RA research reactor facility. It is planned to convert the reactor building for usage for other, non-radioactive related, activities. The first D&D

activities are expected to start after SNF removal from the facility, i.e. in 2011 and last until 2016.

It also includes supporting activities related to nuclear safety of facilities, and nuclear material and radiation protection of employees, the public and the environment during implementation of the programme. Nuclear security and a strong system of physical protection, both on site and during the transportation of the spent fuel, are being upgraded constantly.

The scope of activities and material in the country, and its present vulnerability require a strengthened security system, upgraded physical protection and improved capabilities for combating illicit trafficking.

3. NATIONAL COMPETENCES AND NATIONAL STATUTORY AND REGULATORY FRAMEWORK

3.1. National competences

The constitution of Serbia was enacted on 10 November 2006. The new law on the ministries (effective as of 15 May 2007), adopted after the elections in 2007, determined the responsibilities in the nuclear related fields of nuclear safety, radiation protection, security, science and technology, health, environment, agriculture, transport, etc. The Ministry of Science, under which the Vinca Institute and realization of the VIND programme are, apart from its direct share of responsibilities (nuclear safety and waste, realization of the related programmes in the institutes, R&D, technical cooperation), continued to act as the focal point of the country for national coordination and international cooperation in the nuclear area.

A share of responsibilities rests with the Ministry of Environmental Protection (radiation protection, environmental monitoring, emergency, etc.). The Ministry of Finance — Customs Administration and the Ministry of the Interior and its various directorates (Border Police Directorate, Directorate for Security Protection of Persons and Facilities, Anti-fire Brigade Directorate, etc.), and other relevant State authorities and agencies are among the main competent authorities where the issues of nuclear security and illicit trafficking are concerned. Some authorities are in charge within their main responsibility, as is the Ministry of Health, the Ministry of Infrastructure, the Ministry of Agriculture, etc.

3.2. National statutory and regulatory framework

The law on ionizing radiation protection, adopted in 1996 by the then former Yugoslavia (Official Gazette of SRY 46/96, 4 October 1996) is still in force together with its 17 by-laws. It covers both radiation protection and nuclear safety. The other related fields are elaborated in detail in the accompanying by-laws. Six of them are predominantly related to nuclear safety and 11 to radiation protection. None exclusively addresses the issue of nuclear security, although some aspects are addressed indirectly.

It was recognized by the Government that the present law has to be modernized to comply with international standards and requirements. Some of its shortcomings are that it provides no basis for establishing an independent regulatory authority in line with the IAEA's recommendations and does not sufficiently cover some fields, such as nuclear security. To reach the necessary standards, a new nuclear law (the law on ionizing radiation protection and nuclear safety) was drafted and submitted for adoption. As an interim solution, the Regulatory Commission for Nuclear Safety (later the Regulatory Commission for Nuclear and Radiation Safety) was established in April 2005, with the aim of performing its tasks until a permanent regulatory authority for radiation protection and nuclear safety, fully in line with IAEA recommendations, is established by the new Serbian nuclear law.

National legislation was considered in preparing the draft law in order to have the nuclear law integrated into the comprehensive legislation system and avoid overlaps and gaps. Among them are the:

— Constitution of Serbia (Official Gazette of RS, No. 83/06);
— Law on Ministries (Official Gazette of RS, No. 48/07);
— Law on Environmental Protection (Official Gazette of RS, No. 135/2004);
— Law on Transport of Dangerous Substances (Official Gazette of the former Yugoslavia, Nos 27/90 and 45/90);
— Law on State Administration (Official Gazette of RS, No. 79/2005);
— Law on Civil Servants (Official Gazette of RS, Nos 79/2005, 81/2005 and 83/2005);
— Law on General Administrative Procedures (Official Gazette of the former Yugoslavia, Nos 33/97 and 31/2001);
— Law on Public Agencies (Official Gazette of RS, Nos 18/2005 and 81/2005);
— Criminal Law (Official Gazette of RS, No. 85/2005 of 6 October 2005);
— Ordinance on Transport of Dangerous Substances in Road and Railroad Transport (Official Gazette of RS, No. 53/2002);
— Law on Obligation Relationships (1986).

The draft law also relies on international documents, suggestions and consultations, and other valuable sources, such as IAEA requirements (BSS and Safety Standards Series No. GS-R-1) and European Union Council directives. There is still work to be done on integration and further implementation of the recommendations of some documents, such as the Code of Conduct on the Safety and Security of Radioactive Sources (2004) and the Guidance on the Import and Export of Radioactive Sources (2005).

Unlike the present law, the draft law addresses the issues of nuclear security (physical protection of nuclear facilities, during transport, etc.). Measures for the detection and prevention of illicit trafficking of radioactive and nuclear materials are addressed in one article of the main body of the draft law, which states:

> "In order to detect and prevent illicit trafficking of radioactive and nuclear materials across the borders of Serbia, radiation monitors shall be installed at border crossing points. The regulatory body shall prescribe the procedure for the installation of monitors, their application and intervention. The costs of obtaining, installing, using and maintaining the radiation monitoring equipment shall be born by Serbia from the budget."

The issue is to be elaborated in detail in the new regulations. The draft law introduces the basic elements of national legislation related to security (regulatory authority, licensing, inspection, enforcement, international cooperation, and import and export controls). It also addresses criminal offences, which makes certain acts punishable by appropriate penalties and by taking other appropriate measures against offenders.

4. INTERNATIONAL LEGAL INSTRUMENTS AND INTERNATIONAL COOPERATION

4.1. International legal instruments

Serbia is party to a number of international treaties, conventions and agreements in the nuclear field. The ones related to the field of security are the:

— Treaty on the Non-Proliferation of Nuclear Weapons (Official Gazette of the former Yugoslavia, No. 10/70);
— Agreement for the Application of Safeguards in connection with the Treaty on Non-Proliferation of Nuclear Weapons(1973);

— Convention on Physical Protection of Nuclear Material (signed 15 July 1980, succession, deposit 5 February 2002, in force 27 April 1992);
— Convention on Early Notification of a Nuclear Accident (signed 27 May 1987, succession, deposit 5 February 2002, in force 27 April 1992);
— Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency (succession, deposit 5 February 2002, in force 27 April 1992).

It is a signatory of new/amended instruments not yet in force:

— International Convention for the Suppression of Acts of Nuclear Terrorism (signed 15 September 2005) — Serbia ratified it as one of the first countries in 2006;
— Amendment to the Convention on Physical Protection of Nuclear Material (and Nuclear Facilities) (signed 8 July 2005) but not yet ratified.

It expressed to the IAEA its support/intention to sign by sending a:

— Letter of Intent for signing the Additional Protocol to the Safeguards Agreement with the IAEA in connection with the Treaty on Non-Proliferation of Nuclear Weapons (September 2004);
— Letter of Support to the Code of Conduct of the Safety and Security of Radioactive Sources (2004).

Apart from the legal instruments under the auspices of the IAEA, it is party to:

— The Comprehensive Nuclear Test-Ban Treaty (ratified in 2004);
— The Basel Convention on the Control of Trans-boundary Movements of Hazardous Wastes and their Disposal;
— The Treaty Banning Nuclear Weapons Tests in the Atmosphere, in Outer Space and Under Water (Treaty of Moscow).

Serbia supported United Nations Security Council Resolutions 1373 (2001) — on threats to international peace and security caused by terrorist acts, and 1540 (2004) — on the non-proliferation of weapons of mass destruction and the other ones.

There is an intention to adhere to the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management.

Mostly by succession from the former Yugoslavia, Serbia is party to a number of international bilateral agreements in the field of nuclear energy (e.g. with the USA, Russian Federation, France, China, Argentina, Italy, Romania and Slovakia). It is also party to several scientific, technical and technological agreements, which open legal options for cooperation in nuclear sciences and research. However, a conclusion of some other agreements, related to cooperation within the region, is required.

4.2. International cooperation and combating illicit trafficking

The assistance through IAEA programmes was a key factor in increasing awareness of the need to strengthen the national nuclear security system and national capabilities for combating illicit trafficking of nuclear and other radioactive materials, in establishing intersectoral cooperation (resulted in concluding some memorandums of understanding), in technical modernization of capabilities and monitoring systems at border crossings. National training courses for a significant number of frontline officers (FLOs) and international assistance which is being obtained through the Agency Technical Cooperation Regional Programme and through the IAEA/European Union Joint Action in equipment and training (training of FLOs and members of the expert support team (MEST) and equipping border crossing points and the MEST) contributed to improvement of the system. Assistance in establishing an interactive network for the response of relevant players in cases of illicit trafficking is one of the issues for further cooperation.

Serbia joined the illicit trafficking reporting scheme in 2004. The Design Basis Threat (DBT) is, with the assistance of the IAEA, at a final stage and an integrated nuclear security plan is to be completed on the basis of the findings of the INSServ mission. The country benefited from several expert and fact finding missions with IAEA technical assistance (INSServ, IPPAS, ISSAS, RaSSIA, etc.).

Serbian representatives participated in numerous training courses, workshops, meetings and conferences that were organized by the IAEA, such as an illicit trafficking awareness workshop in Budva, Montenegro (2004), training in Sarajevo, Bosnia and Herzegovina (2005) and Athens, Greece (2006), a national seminar organized by the IAEA in Belgrade, Serbia (2006), a workshop in Karlsruhe, Germany (2006), training in Zagreb, Croatia (2007), as well as conferences on future global directions in nuclear security in London, United Kingdom (2005), on effective nuclear regulatory systems in Moscow, Russian Federation (2006). Much training, expertise, consultations and obtained equipment that resulted in the improvement of physical protection came from international cooperation activities.

International assistance has also been received through the US Department of Energy technical assistance such as the ‘Search and Secure’ orphan sources programme, as well as the Workshop on Civil–Military Response to Terrorism, the Program for Prevention of Global Radiological Terrorism, Combat Proliferation of the Arms for Mass Destruction, ARIEX 06 and many others.

In parallel with domestic efforts, international assistance will be essential in the future for the exchange of experiences, networking, in particular with countries in the region, in further training and equipping the relevant national points and players, for integration in global actions and trends with the assistance of international experts and in line with international practice and recommendations.

5. NATIONAL EFFORTS AND CHALLENGES AND FUTURE PROSPECTS IN STRENGTHENING NUCLEAR SECURITY AND COMBATING ILLICIT TRAFFICKING

5.1. National efforts and challenges

The specific political and economic situation in Serbia had a strong impact on all sectors of development. It caused deterioration in the nuclear field, which once was well managed at the national and international level. Now, after a gap of a decade in international cooperation, Serbia is trying to keep pace with the global community. As a country in transition, it is re-establishing its national and international systems and capacities for governing the peaceful uses of nuclear energy. A well and comprehensively regulated nuclear field, and a legal and regulatory frame created to meet national needs and international obligations will enable the country to become successfully integrated in the global community. This assumes restoring the national nuclear security system and reducing the vulnerability of vital areas. Strengthening the capabilities for combating illicit trafficking will contribute to global security by preventing, detecting or responding to malicious acts of unauthorized transfer and the trade of materials and technologies. Its cross-cutting character and shared goals for protecting human life and health require maximized synergy in the process of development of all security related areas and interrelation with the safety and safeguard aspects.

Although prevention of nuclear terrorism is a global international issue, the establishment of an efficient and well defined system for combating illicit trafficking, nuclear terrorism and proliferation is understood to be a national responsibility. Its importance was recognized by the Government in the national development plans and defined as one of the main directions for further cooperation with the IAEA in the Country Programme Framework for

Serbia which is situated in a sensitive region of the Balkans and which borders eight countries. Strengthening physical protection and combating illicit trafficking capabilities, including the regulatory and statutory infrastructure related to them, are among the priorities planned for cooperation.

In order to reduce the risk of nuclear terrorism and proliferation, and with international assistance, in 2002 the Government of Serbia undertook a major action of removal of fresh nuclear fuel from the site of the Vinca Institute next to Belgrade, to the country of origin, for reduction of enrichment. As the first action of this kind in general, this was a remarkable contribution to global security. The complex task of removal of spent nuclear fuel in a bad condition from the RA research reactor and its decommissioning are a continuation of that process. That is the top nuclear priority of the Government of Serbia, which is committed to accomplishing that goal and thus protecting the population of two million people in the capital of Serbia and the wider community from environmental and human danger. This contribution to universal security requires considerable international engagement and assistance.

Due to the extended difficult economic situation in the country, physical protection of radioactive and nuclear materials has not been modernized for decades. By coordinating national efforts, and with assistance from the USA, the European Union and IAEA programmes, the physical protection system for safeguarding sensitive materials and vulnerable radioactive sources, in particular in the Vinca Institute, is being upgraded. Nevertheless, there are many things to be improved and a lot of effort should be made to diminish the risk of having underprotected sources and material, with the aim of protecting the people and the environment.

The country has started to establish emergency response infrastructure, which did not exist in the previous period. Apart from setting up emergency mechanisms on sites, a national emergency response plan and a system to integrate all the relevant national players at the State and professional levels are being created. The authorities have begun establishing an early warning system based on a net of continuous dose rate meters installed all over the country and some other related activities. Bilateral cooperation and arrangements, in particular with neighbouring countries, have been initiated.

Considering the existing nuclear material and activities, and in compliance with Article III of the IAEA Statute, regular safeguards control is carried out in Serbia, so as to ensure nuclear non-proliferation in this easily affected part of Europe. “The combat against the global terrorism”, as stated in the Statement to the 51st Session of the IAEA General Conference “and support to the universal system of safeguards and control of nuclear non-proliferation is understood as a matter of the greatest importance.”

As already mentioned, Serbia is party to a number of international conventions, agreements and other international legal instruments related to nuclear security and combating illicit trafficking. Its commitment is to continue the translation of their provisions into national legislation, to adhere to the other related conventions and to create conditions for their implementation.

5.2. Radioactivity control at borders

Serbia is situated in south-eastern Europe and controls one of the major land routes from western Europe to Turkey and the near east. The total length of its land boundaries is 2027 km. Its neighbouring countries are Albania (115 km), Bosnia and Herzegovina (302 km), Bulgaria (318 km), Croatia (241 km), Hungary (151 km), The Former Yugoslav Republic of Macedonia (221 km), Montenegro (203 km), and Romania (476 km). The length of its waterways is 587 km (primarily on the Danube and Sava Rivers). National efforts have been directed to an integrated border control system. The Ministry of the Interior took over border control from the army in 2005.

Radiological monitors were installed 20 years ago at seven border crossing points. Some of them are still in operation. In the period 1994–2005, in conformity with the Governmental Decision of 1994, radiological control was only carried out for specified kinds of goods and was performed by the authorized technical services, upon the request of customs officers. During that period, several incidents occurred.

In 2005, in line with the Governmental Decision, a Memorandum of Understanding between the Ministry of Science and Environmental Protection — Directorate of Environmental Protection and the Ministry of Finance — Customs Administration was signed, defining customs officers as FLOs. The two State authorities made an agreement on acceptance of preliminary radiological control. According to the Memorandum of Understanding, preliminary radiological control is in the competence of customs officers at the border crossing points. They are to be equipped with pager detectors and trained in their use. If the level of radioactivity of the goods and vehicles passing by the customs officer equipped with a pager detector at the border crossing point is not normal, the customs officer is obliged to inform the environment protection inspector. Such a vehicle or person is to be isolated. The further procedure is in the competence of the environmental protection inspector. Understandably, where the customs officer finds the level of radioactivity to be normal, the customs procedure continues in the usual manner.

Some kinds of goods from a special list defined commonly by the Directorate for Environmental Protection and Customs Administration are subject to additional radiological control. For the goods from that list, radiological examination and/or gamma spectrometry analysis conducted by authorized laboratories are obligatory. It is not foreseen that these tests must be performed at the border crossing point, but the importer must have laboratory findings to present. Before acceptance of the Single Administrative Document, the customs officer checks the laboratory findings and if the results are below the acceptable limits, the goods can be released for free circulation. These procedures relate to goods on the free export and import regime. For goods on the licence regime, it is necessary that an import or export licence be provided. Such licences are issued by the Ministry of Environmental Protection. The importer or exporter has to provide a licence before declaring goods at a border crossing point. Licences are checked at the border crossing point as a precondition for the goods to enter the customs territory of Serbia.

5.3. Future plans and strategy

The vulnerability of the whole region, and of Serbia itself, is emphasized by the fact that a comprehensive national system for combating nuclear illicit trafficking is still not fully in place and that the process of developing a set of appropriate corresponding national mechanisms for preventing, detecting and responding to malicious acts of unauthorized trafficking is still under way. Additional efforts in capacity building are needed due to the fact that the nuclear field is competing for funds, staffing and attention with other important fields of civil society. They all require simultaneous setting up of national systems and mechanisms.

Outdated equipment, deterioration of the status of the facilities, a reduction of the number of staff and knowledge, are among the challenges and the problems that have to be faced in the future. On the other hand, the potential in knowledge, a number of well established procedures and parts of the infrastructure which are still in good shape can provide a solid basis and facilitate efforts in re-establishing, upgrading and updating the nuclear infrastructure and national capabilities for combating nuclear illicit trafficking. Good results in this slow but constant progress, made in the last period, offer prospective and good outlooks for the future. To this end, international cooperation and the assistance of the international community play an enormous role and are essential for further progress.

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THE THREAT OF ILLICIT TRAFFICKING

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1. INTRODUCTION

This is an important theme for discussion: the threats and risks associated with illicit nuclear trafficking; the analysis and evaluation of related information; how the information may be applied to identify threats, patterns and trends, and vulnerabilities. Consideration will be given to how the knowledge can be better shared within regulatory, enforcement and intelligence circles.

2. METHOD

Considerable concern over the illicit trafficking of nuclear material began in the early 1990s following a number of incidents involving the seizure of high enriched uranium. After 11 September 2001, there was growing government and public concern that nuclear and other radioactive material may fall into the hands of terrorists or criminals who could use it for malicious purposes. The IAEA Illicit Trafficking Database (ITDB) now contains more than a thousand confirmed reports of incidents involving smuggling, theft, loss and illegal disposal, illegal possession and transfer, and attempted illegal sales of the material. Additionally, around 800 additional incidents are as yet unconfirmed. This paper examines the threat and context of illicit nuclear trafficking of radioactive material, what is being done to combat such trafficking and highlights where more needs to be done.

3. RESULTS

All States increasingly recognize their responsibility in controlling the unauthorized movement of radioactive material. Efforts are being made to secure national borders through the installation of radiation detection equipment and to ensure that frontline officers have adequate training and support to deal with and respond to seizures and detection alarms. During recent years, dramatic improvements have been seen in equipment and methodologies used for detecting and characterizing illicitly trafficked material. Also, more attention has been focused on increasing the security of transport of nuclear and other radioactive material. Strict control in airports, ports and railways is very important for providing society with the necessary security. There have been incidents in the past involving sarin gas in the underground public transport system in Tokyo, Japan, and bombs in Madrid, Spain, so it is possible to have an incident involving nuclear material.

4. DISCUSSION

The obligations contained in the Convention on the Physical Protection of Nuclear Material, the International Convention for the Suppression of Acts of Nuclear Terrorism, United Nations Security Council Resolution 1540, the Code of Conduct on the Safety and Security of Radioactive Sources and Guidance on the Import and Export of Radioactive Sources are important instruments to require State parties to reduce intentional possession and use of radioactive materials for malicious purposes.

5. CONCLUSIONS

Intelligence services, the army, the navy, the air force and the police together work to avoid illicit trafficking around the world by way of the following actions:

- Examining the risks and threats of illicit trafficking of radioactive material by terrorists or criminals;
- Gaining a better understanding of current and future patterns and trends in the illicit trafficking of radioactive material;
- Determining progress on efforts to establish detection capabilities at borders and to exchange information on developments in detection technology and response methodologies through installation of radiation detection equipment;
- Strengthening existing networks and cooperation for sharing information on illicit trafficking reports on incidents involving smuggling, theft, loss and illegal disposal, illegal possession and transfer, and attempted illegal sales of the material;

— Examining how an enhanced export/import regime can assist in combating illicit trafficking control through unauthorized movement of radioactive material;
— Sharing information on activities intended to implement international obligations, recommendations and guidance relevant to nuclear security;
— Suggest actions by which the international effort, through the IAEA, would be strengthened.

THE LEGISLATIVE AND REGULATORY FRAMEWORK FOR THE SAFETY AND SECURITY OF RADIOACTIVE SOURCES IN NIGERIA
Illicit trafficking as a case study

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Abstract

Radioactive sources are used in many sectors of the Nigerian economy. All the radioactive sources used in the country are imported. The Nigerian Nuclear Regulatory Authority (NNRA) was established in 2001 by the Nuclear Safety and Radiation Protection Act 1995. The Act confers on the NNRA the statutory function for the safety and security of radioactive sources. Through the Act and all its enabling powers, these functions are carried out through the NNRA regulatory control programme comprising regulations and guidance; authorization; oversight functions; emergency planning and response; and ancillary functions. Nigeria has experienced incidents involving loss of control and/or subsequent illegal transboundary movement of radioactive sources in the past. The NNRA has therefore strengthened its regulatory control programme and improved on safety and security, thereby preventing illicit trafficking of radioactive materials by the gazetting of the Nigerian Safety and Security of Radioactive Sources Regulation 2006, Nigerian Transport of Radioactive Sources Regulation 2006 and the Nigerian Radioactive Waste Management Regulation 2006. Significant positive achievements have been recorded in this regard owing to cooperation between the NNRA, law enforcement and governmental agencies including the Federal Ministry of Justice, the Department of State Services, the Nigeria Customs Service, the Nigerian Police Force and the National Emergency Management Agency. Further restrictions have also been made on the entry into and exit from the country of radioactive sources by the designation of certain airports and seaports. The above successes notwithstanding, enhancing national capabilities in the area of detection at the ports of entry and international cooperation leading to the exchange of information between importing and exporting countries of radioactive sources, among others, still remain a challenge. The IAEA's ongoing programme on the upgrading of nuclear security infrastructure in Nigeria is also mentioned.

1. INTRODUCTION

Radioactive sources find uses in different sectors of the Nigerian economy and these include the petroleum industry, the mining industry, the manufacturing industry, the construction industry, agriculture and water resources, the health sector and in education and research. The petroleum industry is the largest importer and user of radioactive sources in the country. Other uses in the country are the nuclear research reactor and several neutron generators. There are several hundred radioactive sources for various applications in these practices. These include the six radiotherapy centres, and several nuclear well-logging, industrial radiography, nuclear gauging and radio-diagnosis facilities. Before May 2001, there was an uncoordinated approach for controlling activities involving radioactive sources in the country by several government agencies, although the Nuclear Safety and Radiation Protection Act [1] was promulgated in 1995. The Act provides for the establishment of the Nigerian Nuclear Regulatory Authority (NNRA) which was, however, only established in May 2001. The NNRA is the only government organization saddled with the overall responsibility for nuclear safety and radiological protection regulation in the country. Thus, the five major regulatory functions of the NNRA include ensuring safety, radiation protection, security of radiation sources, safeguards of nuclear materials and physical protection of nuclear installations. It should be noted that the safety and security of sources is guaranteed through an effective regulatory control programme.

2. SECURITY CONCERNS FOR RADIOACTIVE SOURCES IN NIGERIA

Major security concerns for radioactive sources usage in Nigeria, based on our experience, include theft of radioactive sources for their shielding material, illegal transfer of radioactive sources, in-country transport of radioactive sources, sabotage and vandalization in the oil industry. Other concerns having security implications are the temporary storage of itinerant radioactive sources and the occurrences of legacy and orphan sources. In addition, illicit trafficking in radioactive material becomes very important when the total border areas of the country and the several numbers of entry points, both staffed and unstaffed are considered, most of which have no capability for radiation detection.

3. LEGISLATIVE AND REGULATORY INFRASTRUCTURE

The major infrastructure for regulatory functions in the country is the Nuclear Safety and Radiation Protection Act of 1995. It is through the mechanism of these infrastructures that the above security concerns are addressed.

3.1. Responsibilities

According to Sections 4 (1 & 2) of the Act, the NNRA has the responsibility for nuclear safety and radiological protection regulation in the country. These responsibilities, among others, are:

- Regulating the possession and application of radioactive substances and devices emitting ionizing radiation;
- Ensuring protection of life, health, property and the environment from the harmful effects of ionizing radiation, while allowing beneficial practices involving exposure to ionizing radiation;
- Advising the Federal Government on nuclear security, safety and radiation protection matters;
- Liaising with and fostering cooperation with international and other organizations or bodies concerned having similar objectives;
- Regulating the introduction of radioactive sources, equipment or practices, and existing sources, equipment and practices involving exposure of workers and the general public to ionizing radiation.

3.2. Powers

To carry out these responsibilities, the NNRA is empowered by Section 6 of the Act to, among others:

- Categorize and license activities involving exposure to ionizing radiation, in particular, the possession, production, processing, manufacture, purchase, sale, import, export, handling, use, transformation, transfer, trading, assignment, transport, storage and disposal of any radioactive material, nuclear material, radioactive waste, prescribed substance and any apparatus emitting ionizing radiation;
- Establish an appropriate register for each category of sources or practices involving ionizing radiation;
- Issue codes of practice which shall be binding on all users of radioactive and prescribed substances, and of sources of ionizing radiation;

— Protect the health of all users, handlers and the public from the harmful effects of ionizing radiation;
— Provide training, information and guidance on nuclear safety and radiation protection;
— Establish, in cooperation with other competent national authorities, plans and procedures which shall be periodically tested and assessed for coping with any radiation emergency and abnormal occurrence involving nuclear materials and radiation sources.

4. REGULATORY CONTROL PROGRAMME

The regulatory control of radioactive sources in Nigeria is derived from Section 4 (1) of the Nuclear Safety and Radiation Protection Act. The main elements of the regulatory control programme are:

— Regulations and guidance;
— Authorization;
— Oversight functions;
— Emergency planning and response;
— Ancillary functions.

4.1. Regulations and guidance

In accordance with Sections 47 (1 & 2) and Sections 6 (d & e), the NNRA developed and promulgated in 2003 the Nigeria Basic Ionizing Radiation Regulations (NiBIRR) [2], which covers all uses of radiation sources in the country, including import and export. According to Regulation 79 of the NiBIRR, any employer who intends to import a sealed source containing any radioactive material for any practice shall:

— Require the supplier, as a condition of any contract for the purchase or transfer, to receive the source back;
— Submit to the authority a copy of relevant parts of the purchase or transfer document and obtain its authorization prior to entering the contract in force or accepting the source;
— Return the source to the supplier within six months after its useful lifetime.

Furthermore, the NNRA has adopted the IAEA Code of Conduct on the Safety and Security of Radioactive Sources [3]. The Nigerian Safety and

Security of Radioactive Sources Regulation [4] was promulgated in 2006. The new regulations fully implement this Code and the Guidance on the Import and Export of Radioactive Sources [5]. Furthermore, as a catalyst to preventing illicit trafficking, both transporters and freight forwarders of radioactive sources in Nigeria must be authorized as provided for in the Act and the Nigerian Transport of Radioactive Sources Regulation 2006 [6]. The transfer of radioactive sources is also prohibited by law even between authorized users or to an unauthorized user, unless such transfer is authorized. This is also depicted in the terms and conditions of licence.

4.2. Authorization

Section 6 (1) of the Act empowers the NNRA to issue authorization for all activities involving exposure to ionizing radiation. Thus, the import and export of radioactive sources require authorizations in the form of licences. In fact, the licensee is obliged by the terms and conditions of the licence to inform the NNRA of receipt of imported sources or of the departure and receipt by the consignee of exported sources. Furthermore, Section 19 of the Act requires that no source or practice shall be authorized except through a system of application, notification, registration or licensing as established by the NNRA. The authorization presently can be in the form of notification, permit, certificate or licence. This is very important for the safety and security of radioactive sources especially for preventing illicit trafficking in radioactive sources. Furthermore, the control of radiation sources and premises where they can be used or stored are strengthened by Section 15 of the Act. In fact, in accordance with Section 20 of the Act, no person can carry out any activity under the Act and at the end of the activity abandon, decommission or rehabilitate installations thereof without a licence issued by the NNRA. This essentially is a codified demonstration of the 'from cradle to grave' principle of the IAEA.

The authorization procedure involves the following stages:

— Notification;
— Submission of completed authorization form;
— Evaluation of application;
— Pre-authorization inspection;
— Issuance or denial of authorization.

4.3. Oversight function

The oversight functions of the NNRA as provided for by the Act are inspection, enforcement and investigation.

Upon satisfactory documentation, a pre-authorization inspection is conducted in the case of fresh or renewal of application. The inspection which is usually carried out by two inspectors has the objective of verifying claims made on the application form with regards to storage facility, intended use, staff competencies, radiation protection programme and security of radioactive sources. The observations are documented in writing and in photographs; a concordance statement is signed by both the inspectors and the prospective licensee. In the case of an export licence application, a pre-shipment inspection is conducted to verify adequate packaging, labelling and radiation protection programme. These inspections are conducted in accordance with Section 37 of the Act.

Upon submission of the inspection report according to Section 39 of the Act, the application is reviewed along with the report by different officers of the NNRA. A recommendation is thereafter submitted to deny or grant authorization. If the recommendation is positive, the authorization is granted for a specific period with specific terms and conditions. It is pertinent to state here that with regard to preventing cases of illicit trafficking of radioactive sources, the inspections have positively impacted on the inventory of radioactive sources. Presently, radiation sources in the health sector, in the petroleum industry, in the educational and research institutions including the manufacturing industry, where radioactive sources are used in the form of fixed nuclear gauges have all been captured. These are being entered into the updated software distributed by the Agency Regulatory Authority Information System (RAIS).

The Act in Section 16 (4)(b) empowers the NNRA to impose such conditions as those requiring the licensee to furnish it with information on the removal of nuclear materials, radioactive substances or sources of ionizing radiation from a registered premises to another.

The Acts in Section 32 also provide for the NNRA the powers to invalidate or suspend an authorization or to revoke an operating licence of a licensee if there are serious violations of the conditions prescribed in it. The licensee shall also not grant or transfer, either totally or partially, any right or obligation specified in the licence issued to him. Penalties for contravention of any of the provisions of the Act are provided for in Section 45.

4.3.1. Features of the licence

On the licence is indicated the purpose of the licence, full address of the licensee, expiry date and distinct authorization number providing information on practice, type of licence, serial number and year of issuance. The licence also includes the isotope, the activity, identification number and country of manufacture. A list of authorities such as the Nigerian Customs Service (NCS), the Nigerian Police Force and the State Security Service, that are issued with copies of authorizations are also listed on the authorizations.

Furthermore, in accordance with Section 21 (3) of the Act, the NNRA is empowered in issuing a licence to impose such terms and conditions in the interest of health, safety and security. Such conditions indicated on the licence include importation through designated airports and seaports and fulfilling requirements for physical security, transport and radioactive waste management (e.g. return of spent sources to the manufacturer), among others.

4.4. Ancillary functions

The Act provides for the NNRA in Section 6 (g) to provide training, information and guidance on nuclear safety and radiation protection. In this regard, the NNRA organizes national training courses, workshops and seminars. In November 2006, the NNRA organized a national workshop on security in the storage and transport of radioactive sources in the petroleum industry, having realized that transport is the weakest link in ensuring security of radioactive sources and preventing illicit trafficking in the country.

The NNRA has also commenced the training of law enforcement organizations and emergency response organizations. In March 2007, a national training course on radiation detection equipment for frontline officers was jointly organized by the NNRA and the IAEA in Lagos, Nigeria. Relevant to this is the conclusion of a memorandum of understanding (MOU) with the NCS in July 2007. The MOU provides for the inclusion in the curriculum of training of NCS basic radiation protection and detection equipment, among others. The NNRA is further engaging other law enforcement organizations with the objective of the conclusion of an MOU. It should, however, be noted that relevant organizations have been engaged since the inception of the NNRA, and in line with Section 10 (1) of the Act, the Inter-Ministerial Committee on Nuclear Security was set up in 2003.

The National Institute of Radiation Protection and Research has also been set up in the country to provide training and technical services that will support prevention of illicit trafficking in the country. Additionally, facilities for detection and identification of radioactive materials are also available at the Centre for Energy Research and Training (CERT), Ahmadu Bello University, Zaria. The NNRA is also cooperating with CERT on management of orphan and legacy sources, and an MOU has been concluded.

4.5. Emergency preparedness and response

Section 6 (h) of the Act provides for the establishment, in cooperation with other competent national authorities, plans and procedures which shall be periodically tested and assessed for coping with any radiation emergency and abnormal occurrence involving nuclear material and radiation sources. In this regard, the National Nuclear and Radiological Emergency Plan has been developed and is awaiting integration into the National Emergency Response Plan.

4.5.1. Relevant experiences on illicit movement of radioactive sources

(1) Halliburton incident

The first major radiological emergency tackled in the petroleum industry by the NNRA was the case of two high risk radioactive materials stolen from Halliburton Energy Services Nigeria Limited (HESNL). The theft was first reported on 24 December 2002. The activities of the radioactive sources were given as 19 Ci (703 GBq) and 0.5 Ci (18.5 GBq). A nuclear security committee was constituted to find the sources. Membership of the committee included the NNRA, the Department of State Services, the Nigerian Police and the NCS. At the end of its search, the committee concluded that the sources never arrived in Warri and that HESNL misled the committee.

After a vigorous search in Warri and Port Harcourt by the NNRA and the security organizations, the NNRA formally informed the IAEA of the radiological incident on 7 February 2003. This is required under the Conventions on Early Notification and Assistance in the Case of a Nuclear Accident or a Radiological Emergency, to which Nigeria is party. The IAEA emergency response team visited the country from 16–20 February 2003 and made some recommendations.

On 5 March 2003, the NNRA formally suspended HESNL from carrying out any activity in the country involving the use, import, transport and transfer of radioactive sources until and unless the two sources were recovered.

At an IAEA international conference in Rabat, Morocco on national infrastructures for radiation safety from 1 to 5 September 2003, a participant from Germany informed the entire conference that two radioactive sources were illegally brought into Germany. He gave further information on the sources, which seemed to tally with those stolen from Nigeria. The information needed to be confirmed by the IAEA and the German regulatory authority. It was in this regard that the IAEA brokered a meeting between the Nigerian and German delegations during the General Conference held from 15 to 19 September 2003 in Vienna.

Further investigations later revealed that the radioactive sources were exported out of the country as scrap metals, and subsequently intercepted by German authorities at a steel recycling plant in the state of Bavaria.

The committee further recommended that the sources in the custody of Halliburton, USA, must be brought back to Nigeria for the Nigeria based company to have some respite on its suspension and for them to be used as evidence in a court of law in Nigeria. In compliance with this directive, the sources involved were authorized for re-importation through an NNRA licence number NNRA/IRS/350/2004 of 28 September 2004 after Halliburton's application for the same was successful. The radioactive sources arrived in Port Harcourt on 5 October 2004 on a chartered cargo plane from the USA. The NNRA reacted swiftly to inspect the packages and identified the radioactive sources on the same day. It was confirmed that these were the same sources that were stolen from Halliburton in December 2002. With this, having complied with other demands by the Federal Government of Nigeria including the export of all junk sources in its operation, Halliburton applied for NNRA authorizations and the ban on Halliburton was lifted in October 2005.

(2) SGS inspection incident

The NNRA received two reports from the Safety Regulation Group, Dangerous Goods Office, United Kingdom Civil Aviation Authority (UKCA), and the Radioactive Materials Transport Division, United Kingdom Department of Transport, respectively, on an incident involving the transport of radioactive materials disguised as 'mould' from Nigeria to the United Kingdom on 29 November 2004.

The incident involved the freighting of radioactive materials disguised and misdeclared as 'mould' by an unaccredited freight forwarder — Greenwich Maritime Agencies Nig. Limited (GMANL) for its client — SGS Inspections Services Limited (SGS) — owner of the radioactive sources. Upon arrival in London, the deception was discovered at the point of collection by the consignee who promptly alerted the United Kingdom relevant authorities. On receipt of the reports, the NNRA invited the two principal parties involved, SGS and GMANL, to a meeting also attended by members of the national nuclear security committee.

(3) The incident and the facts

The UKCA received an incident report concerning undeclared radioactive materials which occurred on 29 November 2004. The goods were carried on an Emirates flight from Lagos. Following collection by the consignee, it was discovered that:

- A consignment of radioactive material had been shipped without having declared it;
- The outer package was not marked or labelled as dangerous goods;
- No shipper's declaration accompanied the consignment;
- Upon inspection, it was discovered that a correctly marked and labelled wooden crate had been overwrapped with a fibreboard box that was unmarked. The United Kingdom competent authority was convinced the goods were signed for as 'mould'. A valid "Certificate of Approval of Package Design for the Carriage of Radioactive Materials" issued by the United Kingdom competent authority was available.

Information and documents showed that SGS labelled and declared the cargo as radioactive material to the forwarder. The NNRA was, however, not informed of the export of the package as required by the terms and conditions of the licence.

In respect to the above, the NNRA conducted preliminary investigations and it revealed the following:

- The export of the radioactive materials concerned was licensed by the NNRA as required by the Nuclear Safety and Radiation Protection Act 1995;
- Parts of the terms and conditions of the licence required the radioactive sources to be exported from Port Harcourt International Airport. Additionally, SGS was required to notify the NNRA upon completion of packaging of the sources prior to transport, for a pre-shipment inspection by the NNRA. The responsibility for safety and security of the sources cannot at any time be transferred;
- SGS did not notify the NNRA for a pre-shipment inspection as required by the licence;
- The forwarder overpacked the container, and sent it to the Emirate Airlines apparently to obtain lesser charges;
- The export took place from Lagos instead of from Port Harcourt as authorized;

— SGS did not report the incident to the NNRA even though it was aware of it from the beginning and, indeed, its managing director was present in the United Kingdom when the cargo arrived;
— The submissions by the managing director of GMANL suggested that lesser agents not under his control may have overpacked and mislabelled the ‘correct’ packaging made earlier by SGS.

From the preliminary investigation, it was clear that:

— SGS bears a significant burden of the violations of the terms and conditions of its export licence and the requirements of the Act;
— GMANL deliberately overpacked the transport package to conceal its true content, apparently to secure lesser freight charges.

In view of the gross violation of the Act, the NNRA ensured the prosecution and conviction of the parties involved. Other parties who handled the radioactive sources without authorization were prosecuted and convicted at the Federal High Court in Nigeria.

4.6. Challenges

Nigeria shares a border with Benin, Niger, Chad and Cameroon, with few official and several unofficial entry points. Monitoring illicit trafficking at these entry points presents serious challenges.

Also, transboundary movement of scrap metals even within the subregion appears to be on the increase. There is still no government body responsible for the control of this business.

The NNRA is also challenged with the training of frontline staff of the Nigerian Police, the NCS, Nigerian Immigration, Airport and Civil Aviation Authorities, Cargo Handling Companies and State Security, among others.

Though few entry ports have been designated in the country for importation and exportation of radioactive sources, this cannot be said to be a long term solution if it must prevent incidents of illicit trafficking in radioactive material. Thus, Nigeria needs to develop capabilities in radiation detection and identification at the various ports. The incidents illustrated above indicate that there is no capacity at our ports of entry for the detection and identification of radioactive materials and this deficiency has, in the recent past, led to incidents of significant international dimensions. Given the possible adverse radiological hazards associated with improper handling and managing of radioactive materials, and the fact that all radioactive materials used in Nigeria are imported, it became imperatively manifest that Nigeria needs to install portal monitors at the major ports. In this regard, the NNRA requested the IAEA for technical assistance to upgrade nuclear security at our ports of entry. In response to this request, the IAEA sent a mission to Nigeria from 23 to 24 November 2005. The mission was to evaluate some of our ports for the possible siting of a portal radiation monitor. The IAEA mission along with some members of the nuclear security committee visited some of our ports in the Lagos area. A project to install a portal monitor at the Murtala Mohammed International Airport (MMIA) is still ongoing.

ACKNOWLEDGEMENTS

The author wishes to express his sincere appreciation to the IAEA for sponsoring his attendance at this international conference. He is also grateful to the management of the NNRA for ensuring his release, thus enabling him to participate in this event.

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TESTING AND IMPROVING THE DETECTION CAPABILITY OF PORTAL MONITORING SYSTEMS AT HIGHER TRANSIT SPEEDS

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Abstract

The aim of the paper is to validate the sensitivity of a typical portal monitoring system at high transit speed up to 44 m/s (160 km/h) and to enhance the detection capability of a prototype system by improvement of the signal processing. It has been demonstrated that speed dependent signal processing can improve the detection capability of portal monitoring at higher speeds. At 50 km/h, the minimum detectable activity (MDA) could be reduced by a factor of two and at 90 km/h by a factor of three compared to a fixed integration time of 1 s. Subsequently, these alterations can be introduced into series production to obtain special monitors to be used at higher transit speed. The signal processing has also been optimized for the scanning of long objects, such as railway trains. For the field test, six pillars, providing a total detector volume of about 138 L were installed at a railroad track near Vienna. The speed dependent data processing and decision making was carried out externally by a personal computer, processing only the raw data (count rate) received in 40 ms intervals. The system was tested at various speeds to evaluate the detection capability as a function of the transit speed. The quantum efficiency was experimentally measured, to characterize the dependence on the distance to the detector for an object moving in a straight line, passing the portal. Based on the shape of the detection efficiency, a new algorithm for the signal processing was developed. The algorithm uses speed dependent adaptation of the scan interval, based on optimization of the signal to noise ratio. Finally, the performance (detection capability), at various speeds, of the original and the new signal processing algorithm are compared. This comparison also includes consideration of the false alarm rate, to allow realistic comparison of the results.

1. INTRODUCTION AND MOTIVATION

The detection capability and sensitivity of a portal monitoring system depends on the count rate statistics. The net signal level increases with the size (efficiency) of the detector and decreases with rising transit speed due to the shorter measurement time. Therefore, it is reasonable to pass the portal at slow speed to increase the detection sensitivity and to reduce the costs for the detectors. Most applications follow this rule and so the typical transit speed for scanning vehicles is about 8 km/h. Usually, the monitors are placed at a gate or checkpoint where the vehicles pass at slow speed. Hence, most monitoring systems have been developed and optimized for rather slow speeds and are not prepared for the scanning of fast objects.

At higher speeds, most portal monitoring systems lose sensitivity, not only because of the inferior measurement statistics but also because their signal processing is not intended for higher transit speed. Most systems can be configured even for higher speeds, but this results in reduced sensitivity at lower speeds. The user has to decide on adjusting the system for a certain speed range.

If higher and varying transit speed is required, for technical or economic reasons, more advanced signal processing is needed, to reach the theoretical limit for the sensitivity, as set by the measurement statistics. Such measurement situations can be underground trains or railway junctions, where the traffic load is heavy and retardation, as it is usually done for car or truck monitoring, is too expensive or not possible. The intended application for the new system is the scanning of railway cars at a test point near Vienna. The test point already accommodates measurement systems for acoustic noise, axles and wheels of the train cars and has now been complemented with portal monitors. The system has been designed to prove measurement availability at higher transit speeds and to get an initial estimate of the amount of transport of radioactive goods on trains.

Because of its big detector size of 46 L of polystyrene in each portal (two pillars), the typical commercial portal monitoring system, YANTAR 2L, was used for testing the algorithm. For the laboratory tests, a single pillar (23 L polystyrene) was used, because the results can be easily scaled for another system configuration. For the field test near Vienna, six pillars were used to enhance the sensitivity.

2. DESCRIPTION OF THE SPEED DEPENDENT SIGNAL PROCESSING ALGORITHM

The common way to detect a source is to process the count rate signal from the detector and to trigger the alarm if the count rate rises above a predefined level, based on the statistical fluctuation of the background. Typically, a value of about four times that of the standard deviation is used and this limit is updated continuously. The fixed integration interval is selected according to the expected transit speed. Selecting too short an interval results in cutting the signal off, while a very long interval will integrate too much noise and weaken the signal. The optimum interval size should match the width of the signal peak getting smaller at increasing speed. Therefore, the speed dependent algorithm varies the integration time, which is used to scan the incoming count rate to maintain an optimum signal to noise ratio.

For a source passing the monitor, the quantum efficiency, depending on the position of the source on the track and on the off-set of the track, was measured and used to calculate the signal to noise ratio, depending on the integration time. The speed of the object is measured and used to calculate the optimum integration time. Therefore, the system integrates less background noise, without cutting the signal too much, at any speed. The intended applications of the speed dependent algorithm are:

— Vehicle monitoring at constant but different speeds to be found in trains, trucks or cars;
— Vehicle monitoring at varying speeds, occurring in the acceleration phase of underground trains.

3. IMPLEMENTATION AND VERIFICATION OF THE SIGNAL PROCESSING ALGORITHM

For laboratory performance verification of the signal processing algorithm, a point source was used to simulate the signal from a passing train containing a source. A source pneumatically driven transport system was designed to allow flexible operation using different sources at various speeds in the range of 1 to 50 m/s. The path of the source can be adjusted at will by positioning the pipe in the required way. The speed and position of the moving source is computer controlled. This allows testing of portal monitors at different speeds and closest distance. The measured data were used for the development and optimization of the algorithm and for testing its implementation before deployment in field tests. Figure 1 shows the test system for verification of the algorithm.

FIG. 1. The source transport system for testing of portal monitors.

The portal monitors were set up to send count rate data every 40 ms and these data were processed by a personal computer. The new algorithm for processing and decision making was implemented. Figure 2 shows the count rate signal at various speeds. The new algorithm adapts the integration interval according to the width of the signal peak and scans by moving this interval over the measured data.

4. APPLICATION OF THE SYSTEM FOR TRAIN MONITORING

To test the operation of the system, a set of six portals was installed at a railroad track near Vienna. This project was supported by the Department for Research and Development of the Austrian National Railways (Österreichische Bundesbahn, Infrastruktur Bau-AG, Stab Forschung und Entwicklung).

The speed of the train is assumed to be constant and is measured using two Frauscher wheel sensors. The signals from the portals are delayed and synchronized according to the transit speed of the train. Analysis and Monte

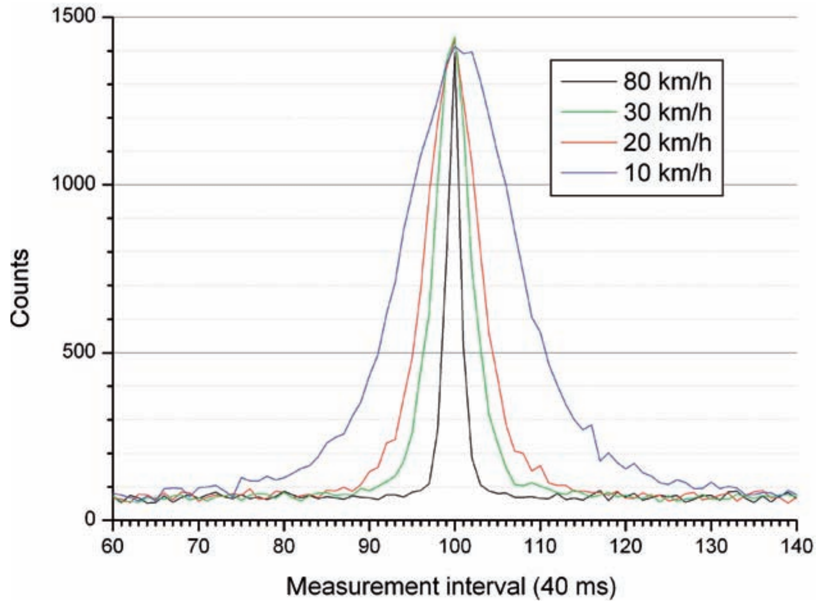

FIG. 2. Count rate signals at various speeds.

Carlo simulation of the system showed that summing up the signals of the six portals and applying the source detection algorithm on the sum leads to better sensitivity than applying the algorithm to each independent portal and combining the alarms. Before field installation, the system was tested at the Seibersdorf site.

The system has been operational since mid-September and will give a spot check of Austrian railway traffic. To validate operation, different point sources have been packed into small containers for transport of dangerous goods and passed through the monitoring system inside a special chartered train at various speeds between 10 and 120 km/h.

Figure 3 shows the test system near Vienna consisting of six chained portals. The personal computer for signal processing, speed measurement and decision making is located in a small hut close to the detectors. Data are stored locally and periodically transferred to a central server.

FIG. 3. The monitoring system near Vienna consisting of six chained portals.

5. COMPARISON OF NORMAL AND SPEED DEPENDENT SIGNAL PROCESSING

To test the sensitivity of the speed dependent signal processing, the detection capability for a point source at various speeds was compared to a typical common configuration. The fixed integration time was set to 1 s, which is a typical choice. This gives an optimum sound to noise ratio at about 5 km/h for a 60 kBq ^{137}Cs source passing by at a distance of 1 m. For testing, a source of about 6 MBq ^{137}Cs was passed by the portal monitor at a close distance of 1 m using different constant speeds. From the signal of the source and the background, the MDA was derived. The process was assumed to follow Poisson statistics and the MDA was calculated according to an alarm threshold (for critical level, see Refs [1, 2]) of four times the standard deviation, which corresponds to a false alarm rate of about 1 in 30 000. The probability for detection of a source at MDA level was set to 95%, which raises the MDA, by an additional two times the standard deviation above the critical level.

Table 1 shows the MDA for a ^{137}Cs point source at different speeds for different integration times. The table is calculated for one pillar (23 L) located

TABLE 1. DEPENDENCE OF THE MDA ON THE INTEGRATION TIME AT VARIOUS SPEEDS

Speed		MDA in kBq depending on the integration time							
in km/h	in m/s	10 ms	25 ms	50 ms	100 ms	250 ms	500 ms	1 s	3 s
5	1.4	440	278	196	140	91	71	64	81
10	2.8	440	278	198	142	100	90	100	156
20	5.6	440	280	201	151	127	141	182	305
50	14	318	288	223	200	239	318	442	761
80	22	446	302	256	266	363	500	703	1215
100	28	450	315	283	314	449	314	886	1521
160	44	465	362	376	468	708	994	1403	2430

in 1 m off-set to the trajectory and under the assumption of negligible shielding of the vehicle (rail car).

The highlighted elements in the table show that speed dependent signal processing provides the optimum MDA, for higher speeds, whereas the fixed integration time is optimized only for a certain speed range. Other methods for improving sensitivity are the use of matched filtering or weighted nonlinear least squares to extract the signal from the background noise [3]. The influence of smoothing and correction of the background suppression has been investigated in several sources [4–6]. The combination of these techniques and implementation into a system is challenging because of interaction.

6. CONCLUSIONS

It was demonstrated that speed dependent signal processing can improve the detection capability of portal monitoring at higher speeds. At 50 km/h, the MDA can be reduced by a factor of two and at 90 km/h by a factor of three compared to a fixed integration time of 1 s. The possible improvement of the sensitivity is dependent on the source position and is also affected by the self-shielding of the vehicle. It is planned to also investigate these two factors in the continuation of the study.

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MULTIFUNCTIONAL HANDHELD GAMMA RADIATION SPECTROMETERS AND THEIR APPLICATION IN VARIOUS RADIATION MONITORING TASKS

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Abstract

Multifunctional handheld gamma radiation spectrometers developed in ATOMTEX SPE are presented in the paper. Their main application is measurement and processing of gamma radiation spectra, searching, localization and identification of natural, industrial, medical radionuclide sources and nuclear materials, definition of radionuclide activity without sampling selection, and the measurement of gamma radiation ambient dose rate, measurement of flux density of alpha, beta and neutron radiation with the possibility of site location. Spectrometers have an intuitive user interface, can store up to 300 spectra and have the possibility to connect to a personal computer to work with it as a spectrometer and to transmit measured spectra and further their processing with the help of developed software. The spectrometers' set-up is as follows: a processing unit or computer and external detection units of gamma, alpha and beta radiation. Spectrometers can be modified for use, for example, in environment monitoring, radioactive waste control, radioactive and nuclear materials trafficking control, geological exploration, scientific research, surreptitious scanning of rooms and territories, and search of nuclear terrorists.

1. BACKGROUND

The illicit trafficking of radioactive substances and nuclear materials is a real threat for security in many countries. Terrorists seek possibilities to obtain and use radioactive substances and nuclear materials to create a weapon which would poison the life of the civilized world for decades. Many companies around the world, in cooperation with international organizations, create equipment that is able to stop illicit trafficking of radioactive substances and nuclear materials. The equipment is being constantly developed using new methods, technologies and possibilities in the detection of radiation, measured data processing and reliable methods of identifying radionuclides. All these efforts should be a barrier for terrorists and their allies at border control points, cargo bays and custom areas, as well as in places of large scale international, social, political, cultural, sporting and other events.

It is well known that illegally trafficked radioactive substances and nuclear materials may be screened not only by passive defence but also by legally trafficked radioactive substances. Such radioactive substances may be contained in the way of medical radionuclides incorporated into a human body as well as in cargoes with an increased content of natural isotopes, such as ^{40}K, ^{232}Th, ^{238}U and others. This creates an additional significant complication in the detection of illegally trafficked radioactive substances.

Simple dosimeters, search monitors or stationary counting portal monitors are unable to cope with the task. It is necessary to use much more intelligent equipment which can detect not only gamma but also other types of radiation (neutron, alpha, beta), define the type of radionuclide and identify it with high probability.

ATOMTEX is one of the developers and manufacturers of such equipment. For many years, we have been developing and producing equipment for measuring and controlling radioactive substances and nuclear materials based on recommendations of the IAEA, standards of the IEC, ANSI and our own experience.

In order to solve the problem of illicit trafficking of radioactive substances and nuclear materials as well as to achieve other aims, we have developed a series of new generation multifunctional handheld gamma radiation spectrometers based on the synthesis of spectrometry, dosimetry, radiometry principles, and physical and mathematical modelling.

2. MULTIFUNCTIONAL HANDHELD GAMMA RADIATION SPECTROMETERS

2.1. AT6101

AT6101 (Fig. 1) and its modifications AT6101A (Fig. 2), AT6101B (Fig. 3), AT6101D (Fig. 4) and AT6101C (Figs 5 and 6) are made as separate functionally finished external detection units, and information procession and indication units.

FIG. 1. AT6101.

FIG. 2. AT6101A.

FIG. 3. AT6101B.

FIG. 4. AT6101D.

2.2. AT6102

AT6102 (Fig. 7) and its modification AT6102A are made as monoblock units which comprise a spectrometric gamma channel and a neutron calculation channel (AT6102).

FIG. 5. AT6101C.

FIG. 6. AT6101C.

FIG. 7. AT6102.

2.3. Application of the spectrometers

Functions of the spectrometers:

— Search and localization of gamma radiations sources;
— Measuring of ambient equivalent of gamma radiation dose rate value;
— Detection of neutron radiation;
— Identification of radionuclide composition;
— Measuring of surface activity of alpha and beta radiation;
— Setting of measuring data with location (radiation mapping).

The spectrometers are designed for the following tasks:

— Control over the trafficking of radioactive and nuclear materials;
— Control of radioactive waste;
— Secret radiation scanning of premises and sites;
— Search for orphan sources;
— Detection of nuclear terrorists;
— Control of objects' radiation pollution;
— Environmental monitoring;
— Geological exploration.

3. CONTROL OVER THE TRAFFICKING OF RADIOACTIVE AND NUCLEAR MATERIALS

Technically, this task is solved by the detection of gamma and/or neutron radiation in an examined object or cargo, localization of radiation source, that is, a search for the maximum radiation intensity point and identification of the radionuclide composition of radiation source.

AT6101 (Fig. 8), AT6101B (Fig. 9), AT6102 (Fig. 10) and AT6102A spectrometers are able to control the trafficking of radioactive sources and nuclear materials, industrial radiation control of metal waste and environmental monitoring.

FIG. 8. AT6101.

FIG. 9. AT6101B.

FIG. 10. AT6102.

The functions of the spectrometers allow you to measure the dose rate, to perform a search, localization and identification of gamma radiation sources, as well as to detect sources of neutron radiation and to measure source activity of alpha and beta radiation.

AT6101 and AT6102 spectrometers can detect a source of gamma radiation of 50 kBq ^{137}Cs at 20 cm within 1 s. The AT6101B spectrometer can detect a source of gamma radiation of 30 kBq ^{137}Cs at 20 cm within 1 s. AT6102 spectrometer is able to detect a source of neutron radiation of ^{252}Cf with flux density of 10 000 n/s at 20 cm within 5 s.

4. RADIOACTIVE WASTE

Radioactive waste can be used as a raw material for making a dirty bomb and terrorism. That is why it is necessary to establish control and security of the waste. A control for leakage or theft can also be made with the above equipment by periodic measuring of gamma radiation dose value at certain points.

5. SECRET RADIATION SCANNING OF PREMISES AND SITES, SEARCH FOR ORPHAN OR HIDDEN SOURCES, DETECTION OF NUCLEAR TERRORISTS

This task is solved by the detection of gamma and/or neutron radiation in an examined area with setting to the location or video control and identification of radionuclide composition of the radiation source. The device should be hidden and any signal should not be able to be noticed by the public to avoid panic or advanced detonation of a dirty bomb. The AT6101C spectrometer was designed for such purposes (Fig. 11).

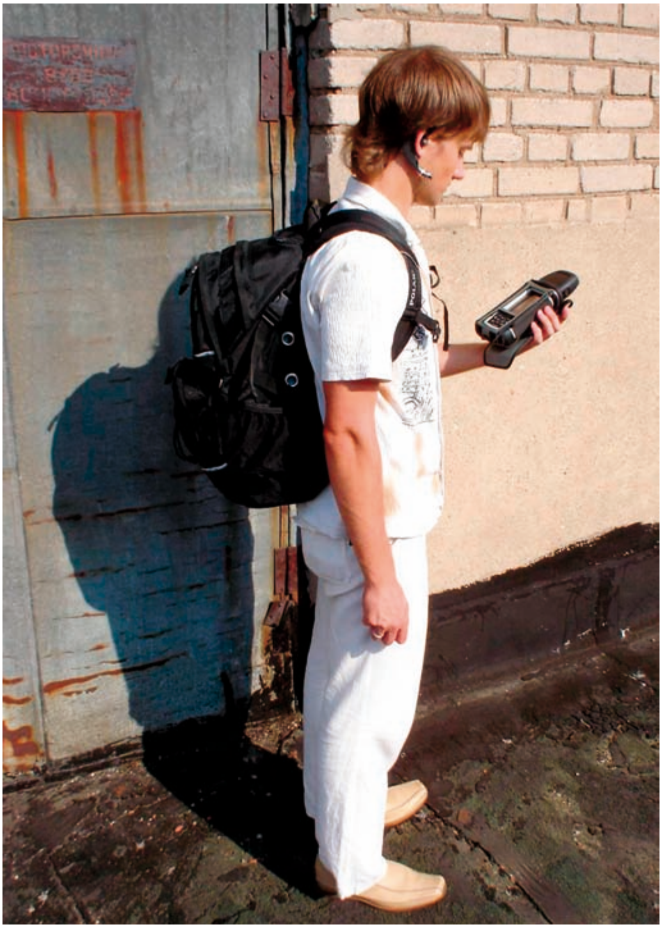

FIG. 11. AT6101C.

AT6101C includes a gamma radiation detection unit with NaI(Tl) ∅ 63 mm × 63 mm detector, a neutron radiation detection unit with two helium counters, a ruggedized handheld computer, a GPS receiver, and a wire or wireless earphone. AT6101C is placed in a comfortable shoulder backpack. One can get all the necessary information through an earphone.

The AT6101C spectrometer can detect a source of gamma radiation of 300 kBq ^{137}Cs at 1 m within 1 s and a source of neutron radiation of ^{252}Cf with a flux density of 10 000 n/s at 1 m within 3 s.

The software allows you to measure the dose rate value, search and detect gamma and neutron radiation, identify radionuclides as well as to perform multivariance analysis of scan data (Fig. 12), that is, count rate and spectra of gamma radiation, radionuclide identification results, neutron count rate, shooting video, snap to field with display of location, dose rate and links to gamma spectrum file on a photographic map (Fig. 13).

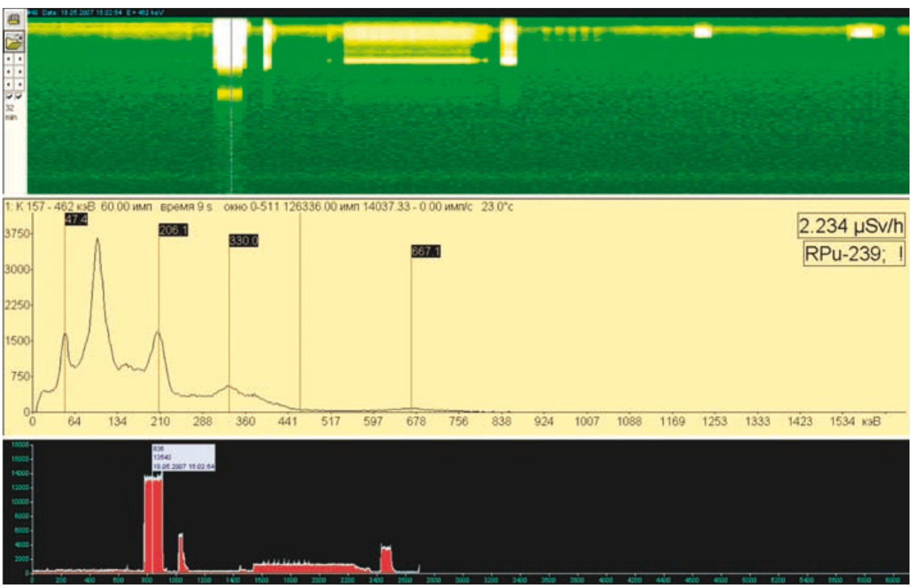

FIG. 12. Multivariance analysis of scan results.

FIG. 13. Scan results on a map.

6. RADIATION CONTROL OF ROCKS, GRANULAR CONSTRUCTION MATERIALS, MEASURING OF SURFACE SOIL POLLUTION WITH ^{137}CS

The AT6101D spectrometer is used for radiation control of rocks in natural locations, and granular construction materials (e.g. granite, rubble and gravel at warehouses and in transport containers), as well as for measuring surface soil pollution with ^{137}Cs (Fig. 14). In addition, it is used to measure gamma radiation dose rate values.

AT6101D measures the effective specific activity of natural radionuclides ^{40}K, ^{226}Ra, ^{232}Th in rock and construction materials in the range of 100–5000 Bq/kg, as well as surface activity of radionuclide ^{137}Cs in the range of 4–3700 kBq/m^2 (0.1–100 Ci/km^2). Confidence limits of measuring error are within ±30% with a confidence factor of 0.95.

FIG. 14. AT6101D.

7. DELIBERATE OR ACCIDENTAL POLLUTION OF OBJECTS AND INDUSTRIAL RAW MATERIALS

Deliberate or accidental pollution of objects and industrial raw materials may have consequences comparable to the blast of a dirty bomb. This includes radioactive construction materials, metal objects and so on.

The control of industrial objects and raw materials pollution is basically measuring the quantity of radionuclides in the object without sampling, identification of radionuclides of non-natural origin and detection of increased levels of gamma radiation. All these should be the reason to exempt the object or raw materials from industrial, economic or social use. The following spectrometers can be used for this:

— AT6101D for measuring the dose value and quantity of radionuclides in objects;
— AT6101 or AT6101B for measuring the dose and identification of radionuclide composition.

8. CONTROL OF RADIONUCLIDE QUANTITY IN OBJECTS

The spectrometer AT6101A can be used to control the quantity of radionuclides in objects according to the user's geometry in laboratory conditions (Fig. 15).

FIG. 15. AT6101A.

IAEA-CN-154/029P

APPLICATION OF INDUCTIVELY COUPLED PLASMA MASS SPECTROMETRY FOR THE CHARACTERIZATION OF URANIUM OXIDE MATERIALS SEIZED IN HUNGARY

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Abstract

The smuggling of nuclear materials is a new challenge for national forensic laboratories. Until recently, the characterization of seized nuclear materials has been carried out by gamma spectrometry. Recently, the analytical capabilities of the Institute of Isotopes of the Hungarian Academy of Sciences (IKI) were complemented by inductively coupled plasma mass spectrometry (ICP-MS) for such purposes. Since the investigated materials are forensic evidence, special attention has to be paid to minimizing the required sample amount. Therefore, beside conventional methods, solid sampling methods based on laser ablation have been developed and also applied for the investigation of the most important parameters: isotopic composition, production date and trace impurities. The paper shows several examples of the application of ICP-MS methods developed at IKI for the characterization of uranium oxide samples seized in Hungary.

1. INTRODUCTION

The smuggling of nuclear materials is a new challenge for national forensic laboratories in Hungary. The task of the categorization and characterization of nuclear material of unknown origin was delegated to the Institute of Isotopes of the Hungarian Academy of Sciences (IKI) in 1996 by governmental decree. The most important parameters of confiscated nuclear materials for characterization are the geometric dimensions, isotopic composition, production date and the amount of trace impurities [1]. The isotopic composition of seized material — mostly low enriched uranium (LEU), natural uranium (NU) and depleted uranium (DU) samples — had been determined by gamma spectrometry. Recently, the analytical capabilities of IKI were extended by inductively coupled plasma mass spectrometry (ICP-MS), because it combines the possibilities of multielement and isotopic analysis with high sensitivity over a wide dynamic range so that the measurable parameters could be extended. This paper shows several examples of the application of ICP-MS methods developed at IKI for the characterization of nuclear materials of unknown origin. Since the investigated materials are forensic evidence, special attention was paid to minimizing the required sample amount, which was achieved by the use of laser ablation (LA) in combination with ICP-MS.

2. INVESTIGATION OF SEIZED URANIUM OXIDE SAMPLES

The aim of the present paper is to give an overview of the developed analytical techniques based on ICP-MS for the characterization of uranium oxide samples seized in Hungary. All of the analysis was carried out using a double focusing magnetic sector inductively coupled plasma mass spectrometer equipped with a single electron multiplier (ELEMENT2, Thermo Electron Corp., Bremen, Germany). The LA studies for the isotopic composition and production date determination were carried out using a UP-213 LA system (New Wave, Freemont, USA. All the technical details of the presented methods have been published elsewhere [2–6].

2.1. Determination of isotopic composition

The isotopic composition of seized material is determined by gamma spectrometry. Recently, the analytical capabilities of IKI were complemented by ICP-MS methods using destructive and quasi non-destructive analytical procedures (LA-ICP-MS).

As an example of the validation of isotopic composition measurements, some results of the Round Robin exercise organized by the Nuclear Smuggling International Technical Working Group (ITWG) are shown in Table 1 [7]. Validation was carried out by re-analysing the high enriched uranium oxide (HEU) samples using destructive ICP-MS analysis. Prior to measurement, a small amount of the HEU sample (~50 mg) was dissolved in nitric acid. For evaluation and validation of our results, the average and uncertainty of all submitted results were used.

In order to decrease the required sample amount and the required analysis time for the determination of isotopic composition, LA assisted ICP-MS methods have been developed. For validation and cross-checking the LA-ICP-MS method, a joint analysis project was carried out between the participation of the JRC Institute of Transuranium Elements (ITU) and IKI [3]. In the frame of the joint analysis, uranium oxide pellets from three different

TABLE 1. RESULTS OF THE ISOTOPIC COMPOSITION DETERMINATION OF HEU ROUND ROBIN SAMPLE

Laboratory (analytical method)	^{234}U	^{235}U	^{236}U	^{238}U
Azores (HRGS, ICP-MS, TIMS)	0.97	89.99	0.68	8.37
Borneo (ICP-MS)	0.85 ± 0.15	86.7 ± 1.5	0.57 ± 0.08	11.9 ± 0.9
Chatam (TIMS)	0.960 ± 0.001	89.94 ± 0.06	0.643 ± 0.003	8.462 ± 0.006
Galapagos (TIMS)	0.96	89.89	0.68	8.47
Mindanao (TIMS)	0.96 ± 0.40	89.91 ± 0.11	0.678 ± 0.23	8.443 ± 1.29
Tobago (ICP-MS)	1.05 ± 0.07	89.37 ± 1.8	0.69 ± 0.05	8.88 ± 0.2
Tonga (TIMS)	0.967 ± 0.001	89.99 ± 0.002	0.679 ± 0.001	8.362 ± 0.005
Trinidad (MC-ICP-MS)	0.995 ± 0.075	90.01 ± 0.35	0.673 ± 0.030	8.365 ± 0.033
Average	0.964 ± 0.055	89.475 ± 1.14	0.661 ± 0.039	8.906 ± 1.22
ICP-SFMS (IKI)	0.964 ± 0.046	89.032 ± 0.420	0.631 ± 0.030	9.373 ± 0.441

batches, corresponding to three different seizures in Hungary, were investigated. Five pellets from each batch were selected for the measurements. First, the isotopic compositions of all the selected pellets were determined by gamma spectroscopy and LA-ICP-MS at IKI. Three pellets from each batch were sent to ITU for further analysis. Table 2 shows the results of the analysis of an LEU sample.

The results in Tables 1 and 2 agreed well within their uncertainties, which indicates that the developed methods are suitable for determination of isotopic composition of uranium oxide samples. The LA-ICP-MS analysis can be

TABLE 2. ISOTOPIC COMPOSITION OF AN LEU SAMPLE*

	MC-ICP-MS	TIMS	IDMS	HRGS (ITU)	HRGS (IKI)	LA-ICP-SFMS
^{234}U	0.0346(5)	0.0347(21)	0.0345(33)	0.025(20)	0.0362(24)	0.0358(9)
^{235}U	2.5136(14)	2.5121(14)	2.5119(30)	2.51(12)	2.562(34)	2.529(19)
^{236}U	0.451(22)	0.47(44)	0.47(86)	—	0.38(24)	0.474(24)
^{238}U	97.000(21)	96.9823(20)	96.9829(12)	97.47(12)	97.021(34)	96.961(2)

* Data are shown in mass %. The uncertainties in brackets denote two standard deviations (‘2 sigma’).

accomplished within one working day, and thus is significantly faster than gamma spectrometry

3. DETERMINATION OF PRODUCTION DATE

The production date determination of the uranium oxide material is based on the decay of the relatively long lived ^{234}U ($T_{1/2}$ = 245250 ± 490 a) to ^{230}Th ($T_{1/2}$ = 75690 ± 230 a) and the disequilibrium between these two radionuclides [2]. These parameters can also be determined using both destructive ICP-MS and LA-ICP-MS methods as shown in Table 3. Uranium oxide pellets with different enrichment (DU, LEU) seized in Hungary were analysed in this study. In order to validate the methods, HEU powder from a Round Robin interlaboratory exercise (RR-HEU) organized by the ITWG was used [7].

The age results of uranium oxides obtained agree with the previously reported values for the Round Robin sample (February to July 1979) [7]. The findings indicate that the production date can also be determined by the LA-ICP-MS technique, which has the great advantage that it does not require the dissolution of the sample and only a small portion (approximately a few µg) is needed for the analysis. However, if more precise age data are required, the destructive ICP-MS method is the optimal method of choice. The previous neutron irradiation can be revealed by the measurement of ^{236}U and plutonium isotopes in the material [5]. The presence of these isotopes and their isotope ratios are characteristic of the former neutron irradiation conditions (e.g. burnup, reactor type); thus, they help to identify the origin of the nuclear material.

TABLE 3. PRODUCTION DATE OF THE INVESTIGATED SAMPLES MEASURED BY ICP-MS

Sample	Destructive ICP-MS method		LA-ICP-MS method	
	Calculated age (a)	Production date	Calculated age (a)	Production date
DU	13.7 ± 1.0	August 1993 (±12 months)	>2.3	Earlier than November 2004
LEU	15.51 ± 0.98	September 1991 (±12 months)	16.1 ± 3.0	February 1991 (±3 a)
RR-HEU	27.9 ± 1.3	June 1979 (±16 months)	30.4 ± 3.8	October 1976 (±3.8 a)

4. DETERMINATION OF TRACE IMPURITIES

The method developing process for impurity determination was described in detail elsewhere [6]. A recovery study was carried out in order to investigate the accuracy of the analytical method including the sample preparation step. A model solution of uranium (approximately 1 mg/mL uranium) containing known amounts of trace elements was analysed after the UTEVA™ separation process. The results are shown in Table 4.

For all investigated elements (except Zn), the recovery was found to be 90.3–101.6%. These results indicate that the extraction chromatographic sample preparation step does not considerably influence the element distribution in the sample. Hence, the method is applicable for the characterization of the investigated elements in the uranium oxide matrix.

TABLE 4. RESULTS OF THE RECOVERY STUDY USING A MULTI-ELEMENT STANDARD SOLUTION

Element	Expected concentration (ng/mL)	Measured concentration (ng/mL)	Recovery (%)
Ag	34.0	32.3 ± 0.6	95.1
Al	33.8	31.5 ± 1.2	93.1
Ba	33.9	31.1 ± 1.2	91.8
Bi	33.9	33.1 ± 1.0	97.6
Cd	33.8	30.5 ± 0.6	90.3
Co	33.9	32.5 ± 0.9	95.9
Cr	33.8	31.7 ± 1.4	93.8
Cu	33.9	34.4 ± 1.3	101.6
Fe	33.9	30.7 ± 1.4	90.5
Ga	33.7	33.7 ± 1.6	99.9
In	33.9	32.8 ± 1.1	96.7
Li	33.7	32.1 ± 0.5	95
Mn	33.9	32.3 ± 1.3	95.4
Ni	33.8	33.9 ± 1.5	100.3
Pb	33.8	32.9 ± 1.0	97.2
Sr	33.9	32.5 ± 0.9	95.9
Tl	33.9	33.6 ± 0.9	99.1
Zn	33.9	24.2 ± 1.1	71.4

The method was applied for the analysis of an HEU powder distributed in the Round Robin interlaboratory exercise organized by the ITWG. For the analysis, approximately 100 mg of sample (RR-HEU) was dissolved in nitric acid. For the analysis, approximately 0.5 mL of this solution was used, which is equal to approximately 3 mg of UO_2 [6]. The results of the analysis and limit of detection (LOD) are shown in Table 5. The detection limits were evaluated as three times the standard deviation of the blank signal divided by the sensitivity of the blank corrected signals obtained for standards (3σ criterion).

TABLE 5. RESULTS OF THE ANALYSIS OF THE RR-HEU SAMPLE

Elements	Concentration (μg/g)	LOD (μg/g)
Ag	0.72 ± 0.02	0.01
Al	18.96 ± 0.40	1.90
As	<LOD	0.06
Ba	1.99 ± 0.04	0.10
Bi	1.63 ± 0.03	0.01
Cd	1.36 ± 0.03	0.01
Co	0.91 ± 0.02	0.01
Cr	1.01 ± 0.03	0.04
Cu	2.29 ± 0.05	0.15
Fe	76.76 ± 1.64	1.52
Ga	0.96 ± 0.02	0.01
In	1.00 ± 0.02	0.02
Li	0.85 ± 0.02	0.01
Mn	2.19 ± 0.05	0.03
Ni	5.26 ± 0.13	0.03
Pb	7.40 ± 0.17	0.16
Sr	1.25 ± 0.03	0.10
Tl	1.63 ± 0.04	0.11
Zn	23.33 ± 0.91	0.01

5. CONCLUSION

In recent years, several improved ICP-MS methods have been developed at IKI for the characterization of seized uranium oxide samples. Since the investigated materials are forensic evidence, special attention was paid to minimizing the required sample amount. Therefore, the conventionally destructive ICP-MS methods were complemented by non-destructive methods using solid sampling methods based on LA assisted sample introduction. The advantage of these techniques is that for one analysis, only a few µg of sample is needed and the analysis can be carried out within a few hours. The LA-ICP-MS methods were also validated by interlaboratory comparisons. Although the precision of the LA-ICP-MS technique is inferior to that of the liquid sample introduction, the uncertainty of the measured parameters is usually adequate for nuclear forensic purposes.

ACKNOWLEDGEMENTS

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IDENTIFYING REPROCESSED URANIUM BY GAMMA SPECTROMETRY

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Abstract

It is shown that low background gamma spectrometry can be successfully used to identify uranium samples made from reprocessed uranium, by measuring the activity of ^{232}U. It is demonstrated that ^{232}U is always present in enriched or depleted uranium samples, but in reprocessed uranium the activity of ^{232}U is at least 100 times higher than in other uranium samples of the same ^{235}U enrichment.

1. INTRODUCTION

Identifying reprocessed uranium is an important clue in the characterization of nuclear material of unknown origin. In order to find out whether an interdicted uranium sample was prepared from material that has already been used in a nuclear reactor and then reprocessed, one should look for traces of fission or activation products. One of the nuclides frequently used for this purpose is ^{236}U, which can easily be quantified using mass spectrometry. With gamma spectrometry, ^{236}U can only be detected in very high enriched (weapons grade) uranium, with quite a large uncertainty. Another nuclide which can only be present in uranium if it has already been used in a nuclear reactor is ^{232}U. This nuclide can be easily quantified by low background gamma spectrometry, regardless of the ^{235}U enrichment.

The activity of ^{232}U is calculated from the activity of its gamma emitting daughters, ^{212}Bi and ^{208}Tl. However, since these isotopes are also present in the decay chain of ^{232}Th (see Fig. 1), determining the activity of ^{232}U also involves the determination of the activity of ^{232}Th. Observing the decay scheme of ^{232}U and ^{232}Th (Fig. 1), and the gamma energies emitted by their daughters, it can be seen that the activity of ^{232}Th can be calculated from the activity of ^{228}Ac which, in turn, can be determined from the gamma peaks of ^{228}Ac at 911 and 969 keV. The activity of ^{228}Ac may be written as:

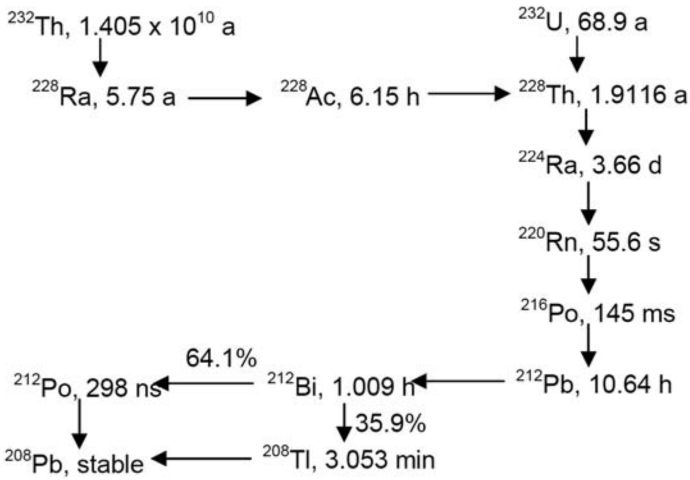

FIG. 1. Decay scheme of ^{232}Th and ^{232}U.

$$A_{Ac228} = A_{Ra228} = A_{Th232}(1 - \exp(\lambda_{Ra228} t)) \tag{1}$$

where A_{Ac228}, A_{Ra228} and A_{Th232} denote the corresponding activities, λ_{Ra228} is the decay constant of ^{228}Ra, while t is the age of the sample. Therefore, the activity of ^{212}Bi and ^{208}Tl can be calculated as the sum of two terms, one of them accounting for the buildup from ^{232}Th and the other term accounting for the buildup from ^{232}U, as described by the following equation:

$$\begin{aligned} A_{Bi212} &= \frac{A_{Tl208}}{f} = \\ &= A_{Th232}\left[1 - \frac{\lambda_{Th228}\exp(-\lambda_{\mathrm{Ra}228}t) - \lambda_{Ra228}\exp(-\lambda_{Th228}t)}{\lambda_{Ra228} - \lambda_{Th228}}\right] + \\ &= \left[\frac{1 - \exp((-\lambda_{U232} - \lambda_{Th228})t)}{1 - \lambda_{U232}/\lambda_{Th228}}\right] \end{aligned} \tag{2}$$

where $f = 35.9\%$ is the decay branching probability of the ^{212}Bi → ^{208}Tl decay (see Fig. 1). Using the measured activities of ^{228}Ac, ^{212}Bi and ^{208}Tl, the measured or estimated age of the sample and the known half-lives, the activities of ^{232}U and ^{232}Th are obtained by solving Eqs (1) and (2) for A_{U232} and A_{Th232}. In the present work, the age of the samples was determined either by low background gamma spectrometry [2, 3], or alpha spectrometry, or from the

TABLE 1. ENERGIES AND EMISSION PROBABILITIES OF THE RELEVANT GAMMA PEAKS IN THE LOW BACKGROUND SPECTRA

Energy (keV)	Emission probability (%)	Emitter
569.30	0.0203	^{234}Pa
583.0	86	^{208}Tl
727.3	6.65	^{212}Bi
766.37	0.3220	^{234m}Pa
1000.99	0.8390	^{234m}Pa
860.3	12.0	^{208}Tl
1193.69	0.0135	^{234m}Pa
1510.20	0.0129	^{234m}Pa
1737.73	0.0212	^{234m}Pa
1831.36	0.0172	^{234m}Pa
2614	97.79	^{208}Tl

available sample documentation. If the samples are older than 1–2 a, then the uncertainty of the age of the sample does not noticeably influence the results for ^{232}U activity.

2. DETERMINING THE ACTIVITY RATIO ^{232}U:^{238}U

In the present work, the activities of ^{212}Bi and ^{208}Tl were determined relative to ^{238}U, using the peaks of ^{238}U to construct a relative efficiency curve. The activity ratio ^{232}U:^{238}U was measured in a low background iron chamber using a 150 cm^3 coaxial Ge detector (“PIGC 3520” Intrinsic Coaxial Detector manufactured by PGT) having 34.1% relative efficiency (at 1332 keV measured at a 25 cm source–detector distance, relative to a 3" × 3" NaI(Tl) detector). The wall thickness of the iron chamber is 20 cm and its inner dimensions are 120 cm × 60 cm × 120 cm (height × width × length). The detector was standing in a vertical position and the samples were placed, one after another, either below the detector or by the side of the detector.

For this study, a set of certified reference materials and several other uranium samples were used, with ^{235}U enrichments in the range of 0.23–90% (see Table 2).

For each sample, an intrinsic efficiency calibration curve was constructed, using the peaks of ^{234}Pa and ^{234m}Pa which are short lived daughters of ^{238}U. Using this intrinsic efficiency curve and the count rates of the relevant gamma lines of ^{212}Bi and ^{208}Tl, the activity ratio ^{232}U:^{238}U was calculated for each assayed sample. The energies and emission probabilities of the gamma peaks were taken from Ref. [4] for ^{234}Pa and ^{234m}Pa, while for ^{212}Bi and ^{208}Tl, they were taken from Ref. [5] and are shown in Table 1.

The activity of ^{228}Ac can be estimated from its peaks at 911 and 969 keV. After subtraction of the background, however, the net count rate of these

TABLE 2. ^{235}U AND ^{232}U ISOTOPIC ABUNDANCES IN THE INVESTIGATED SAMPLES

Type	Local identifier	^{235}U (%)	^{232}U (%)
Certified reference materials			
200 g U_3O_8	cbnm031	0.31	$9.91(44) \times 10^{-11}$
200 g U_3O_8	cbnm071	0.71	$1.74(1.00) \times 10^{-12}$
200 g U_3O_8	cbnm194	1.94	$2.51(71) \times 10^{-11}$
200 g U_3O_8	cbnm295	2.95	$7.03(2.39) \times 10^{-11}$
200 g U_3O_8	cbnm446	4.46	$3.06(50) \times 10^{-10}$
1 g of U_3O_8	NBS U100	10	$6.38(34) \times 10^{-10}$
Various materials			
2 pellets	643	0.23	$1.58(13) \times 10^{-10}$
Pellet	590	0.71	$1.67(21) \times 10^{-12}$
Pellet	644	1.9	$1.04(20) \times 10^{-9}$
3 pellets	598	2.0	$1.11(1) \times 10^{-9}$
Pellet	642	2.5	$7.18(7) \times 10^{-8}$
Pellet	597	4.4	$2.38(3) \times 10^{-9}$
UO_2 fuel rods	EK-10	10	$3.15(18) \times 10^{-10}$
10 g of U_3O_8	KFKI36	36	$2.57(11) \times 10^{-9}$
1 g of U-oxide	RRM	90	$6.92(85) \times 10^{-8}$
1 g of U_3O_8	RFM	90	$5.85(10) \times 10^{-9}$

peaks turned out to be zero within the measurement error or very close to the detection limit in the spectra of all investigated samples. This led to an upper limit for the ^{232}Th activity which is less than about 0.5 Bq/g even for the most ^{232}Th rich sample.

3. RESULTS

The results of the measurements are shown in Table 2 and in Fig. 2. For two of the investigated samples (see the materials with local identifiers 642 and RRM in Table 2), the count rates of the relevant peaks of ^{212}Bi and ^{208}Tl were about 100 times larger than for other samples with similar ^{235}U enrichment and about 1000 times larger than the background, clearly indicating that there is much more ^{232}U in them than in the other samples. It is interesting to note that in all samples, except in the ones with natural isotopic composition, there is some ^{232}U, although it is not a naturally occurring isotope. This is probably due to the contamination in the enrichment facilities. Figure 2 presents the ratio of ^{232}U to the total mass of U in the investigated samples as a function of ^{235}U enrichment, indicating that two of the samples have probably been produced from reprocessed uranium. For one of them (the highly enriched one), this conclusion is also supported by the fact that the 49.4 keV gamma peak of ^{236}U, being only present in irradiated uranium, could also be evaluated in its gamma spectrum.

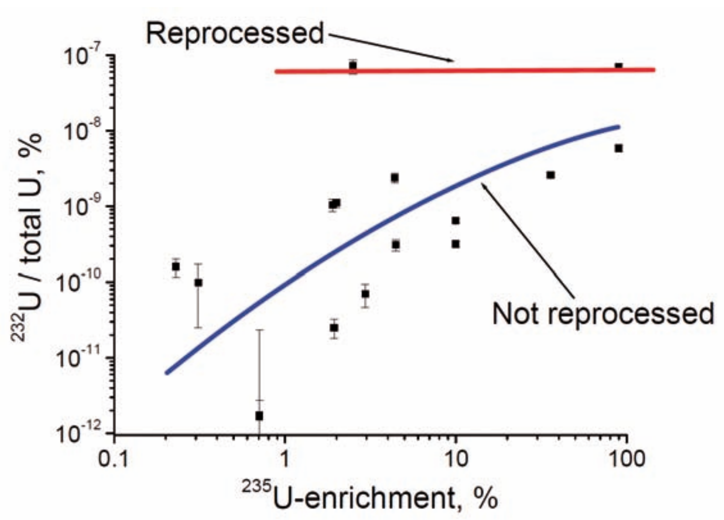

FIG. 2. ^{232}U content as a function of ^{235}U enrichment.

For the certified reference materials and for the samples with local identifiers 590, 642, 643 and RRM, results of mass spectrometric uranium isotope ratio measurements were also available. The mass spectrometric results showed that in those two samples in which a higher amount of ^{232}U was found, there is also much more ^{236}U than in the other ones, confirming that these samples, indeed, contain reprocessed uranium.

It can be concluded that low background gamma spectrometry can be successfully used to show that a nuclear material of unknown origin was made from reprocessed uranium, by measuring the amount of ^{232}U in the sample. Note that a small amount of ^{232}U was found in enriched and depleted uranium samples even if they were not produced from reprocessed material. This is probably due to the fact that the enrichment facilities in which these materials were enriched (or depleted), are also used for enriching uranium from reprocessed irradiated materials, so the facilities might be contaminated by ^{232}U. Nevertheless, samples made from irradiated uranium contain at least 100 times more ^{232}U than those in which ^{232}U occurs merely because of the contamination of the enrichment facilities, making it possible to distinguish between reprocessed and not reprocessed materials.

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TRANSPORT SECURITY OF RADIOACTIVE MATERIAL IN PARAGUAY

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Abstract

Paraguay has implemented diverse mechanisms for the safe transport of radioactive material. Among the first of these was the adoption and implementation of national regulations based on the latest edition of the IAEA's Regulations for the Safe Transport of Radioactive Material (IAEA Safety Standards Series No. TS-R-1). The National Regulation for Protection against Ionizing Radiation and for the Safety of Radiation Sources, in Article 34, states that any transport of radioactive materials must fulfil the IAEA's Transport Regulations. In addition, Resolution No. 4097/00 of the Rector of the National University of Asunción approved the latest edition of the IAEA's Transport Regulations, as the only instrument to be used by the National Commission of Atomic Energy — the competent authority — in authorizing the safe transport of radioactive material, for exports and especially within MERCOSUR, the Common Market of the South.

1. INTRODUCTION

Paraguay imports radioactive material for medical use, with 90% employed in diagnosis and treatment in nuclear medicine. Most of the material is shipped in Type A packages. Sources are also imported for radioimmunoassay (RIA), as well as for industrial use, investigations and teaching. The regular importers have licences which have monthly limits, while foreign companies require proper authorization and licences to import such material into the country.

Carriers must pass a course in the transport of dangerous goods after they have taken a 20 h basic course in radiological safety. Inspections are also required of road transport vehicles as per the requirements of regulations covering radiological emergencies. Users importing directly must also fulfil a number of transport requirements.

By Law 1081/65, the National Commission of Atomic Energy was created as the competent authority to regulate all activities related to the use, possession, purchase, sale and operation of radioactive materials, including their import and export.

Decree No. 10754/00 approved the National Regulation for Protection against Ionizing Radiation and for the Safety of Radiation Sources [1], based on the Basic Safety Standards (IAEA Safety Series No. 115) (Fig. 1) [2]. Article 266 of the National Regulation states that the transport of radioactive material must fulfil the latest edition of the IAEA's Regulation for the Safe Transport of Radioactive Material (the Transport Regulations) [3].

1.1. Regional and international transport

Decree No. 17723/97 authorizes the transport of dangerous goods within MERCOSUR (Common Market of the South). It designates the CNEA as the competent authority in the matter of the safe transport of radioactive material.

Resolution No. 4097/00 of the Rectorado of the National University of Asunción (UNA), adopted the IAEA's Transport Regulations (Fig. 2).

Paraguay signed its adherence to observe the Code of Conduct on the Safety and Security of Radioactive Sources [4] (Fig. 3(a)). It is in the process of preparing a request for observance of the Guidance on the Import and Export of Radioactive Sources [5], the supplement to the Code of Conduct (Fig. 3(b)).

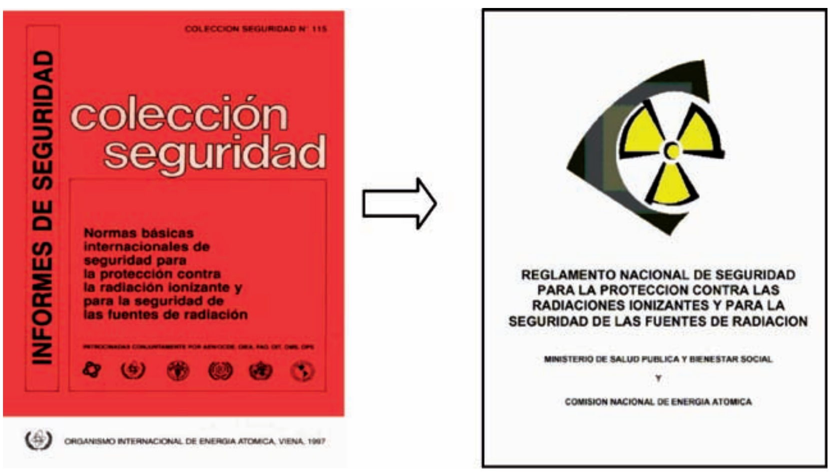

FIG. 1. The National Regulations for the possession and use of radioactive material was elaborated on the basis of IAEA Safety Series No. 115 [2].

FIG. 2. Countries of MERCOSUR that apply the IAEA's Transport Regulations [3], without including the Countries Associate.

FIG. 3. (a) Code of Conduct on the Safety and Security of Radioactive Sources [4]; (b) Guidance on the Import and Export of Radioactive Sources [5].

2. CULTURE OF SECURITY

The country has participated in two courses on the illicit trafficking of radioactive material. The first was the first regional seminar on the control and detection of radioactive material at borders, organized by the IAEA and CNEA UNA in Ciudad del Este, Paraguay, 20–24 October 2003, also known as 'Three Borders'. Argentina, Bolivia, Chile, Paraguay and Uruguay participated in the seminar. The second was a training course for officials in nuclear radiation monitoring, 19–23 March 2007, in Asunción, Paraguay.

Representatives of Paraguay have also participated in three meetings of the IAEA's Transport Safety Standards Committee (TRANSSC).

3. ILLICIT TRAFFICKING OF RADIOACTIVE MATERIAL

The CNEA has participated in four meetings of a Working Group on Illicit Trafficking in Radioactive Material organized by the Departments of the Interior of the MERCOSUR States. There is a plan to start up joint customs operations with the purpose of preventing the illicit trafficking of nuclear fuel by monitoring ports through unified controls. Also, Paraguay has regular communication with the Argentine regulatory authority.

4. CONCLUSION

The activities mentioned permit appreciation of the substantial increase of information on regulatory infrastructure, regulations and harmonized norms published by the IAEA. Radioactive material that is being illicitly trafficked must be monitored along the borders of States using mechanisms which are integrated with the systems of neighbouring countries. Monitoring is also necessary at locations where there is a large volume of trade and at locations where there is heavy cross-border traffic. The Code of Conduct on the Safety and Security of Radioactive Sources [4], the Guidelines on the Import and Export of Radioactive Sources [5] are fundamental tools to facilitate the transport of radioactive material and to avoid illicit trafficking. Also, it is very important to mention that CNEA has an agreement with customs, which has acquired — with the help of the UMBRAL Program of the USA — equipment for the identification of illicit goods using a modern system of scanning of containers.

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LEGAL AND REGULATORY CONTROL TO PROTECT AGAINST NUCLEAR ILLICIT TRAFFICKING OF SCRAP METAL IN BANGLADESH

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Abstract

The objective of the paper is to support the regulatory framework in Bangladesh for monitoring and responses related to radioactive scrap metal regarding nuclear illicit trafficking. The paper provides a framework of recommendations on the existing national regulatory control of all metals used and traded nationally and internationally in Bangladesh as part of the metal recycling industry. The recommendations are addressed to all parties concerned with the metal recycling industry, including demolition companies, scrap collectors, sellers of scrap metal, owners of scrap yards, metal works, transporters, and the departments of government responsible for the control of incoming and outgoing shipments, for example, customs or border authorities. They also address the prevention of the occurrence of radioactive scrap metal which may or may not have been under regulatory control, its detection and the prevention of associated radiological consequences through response actions. The goal of the recommendations is to establish adequate controlling systems for facilities, borders, the transport authority and other relevant parties, to ensure a system of notification of the responsible authorities and persons, and also to create a decision making scheme for different types of illicit trafficking.

1. INTRODUCTION

In Bangladesh, large amounts of scrap are produced from the breaking of ships which are traded nationally and internationally. The first ship to be scrapped was on the Chittagong sea beach in 1960, which started spontaneously when a 20 000 DWT vessel was driven ashore by the devastating tidal bore of 1960. Ship breaking, popularly known as beaching, in Bangladesh started as a business in 1974. At present, there are 24 ship breaking yards in this area and the area that extends for over 14 km along Fauzdarhat to Kumira Coast [1].

Every year, 60–65 ships are either dismantled or awaiting the dismantling process [2]. At one time, about 150 companies were engaged in ship scrapping activities [3]. Ship breaking, scrapping and scrap handling are performed simultaneously in the yards almost all year round without any concerns about hazards and environmental pollution.

These ships contain a wide range of hazardous materials including items containing radioactive materials, for example, smoke detectors installed in the cabins or engine room of the ship, portable carbon dioxide fire extinguisher cylinders, undelivered packages containing radioactive material left behind in cargo ships (if unnoticed by the authorities clearing the ship for breaking), reference sources in warships (used for checking radiation monitors in the ships), and nucleonic gauge source housings (normally used in dredgers), which are beyond safety concern. These radioactive materials subsequently become mixed with scrap metal destined for recycling. Furthermore, the ship may be contaminated to levels higher than accepted by regulatory control due to accidents such as an explosion, fire or collision with another ship, destruction by pirates, and leakage and spillage of containers containing radioactive materials. Such occurences are not considered during ship breaking in Bangladesh.

Recently, the use of scrap metal imported from neighbouring countries, such as India, has been increasing in Bangladesh as overall economic development activities increase. Such imported metal may also be contaminated to levels higher than accepted by regulatory control. Previously, it was not subject to regulatory control.

The unexpected appearance of illicit trafficking of contaminated metal can only be controlled by an effective regulatory framework. Bangladesh has realized that a national legal framework is crucial for preventing, detecting and responding to such illicit trafficking.

In this regard, the Bangladesh Atomic Energy Commission (BAEC) arranged a training workshop on radiation protection awareness for the safe handling of radioactive contaminated scrap materials on 27 August 2005, and realized the necessity of imposing some recommendations on regulatory requirements for such metal.

2. NSRC ACT AND RULES

BAEC is the competent authority for all aspects of radiation protection and safety in Bangladesh. The competencies of BAEC are defined by the Nuclear Safety and Radiation Act (NSRC Act) of 1993 and the Nuclear Safety and Radiation Control Rules of 1997 that are based on the ICRP and the

IAEA recommendations. They are fully harmonized with the Basic Safety Standards [4], and implement all relevant international agreements. The Nuclear Safety and Radiation Control Division (NSRCD) is responsible to BAEC for implementation of the provisions and rules.

BAEC participates in the IAEA's Illicit Trafficking Database programme. BAEC represents the governmental 'point of contact' (for emergency events). NSRCD has the duty of keeping the national system of registration, the control of nuclear material national registration, and the system of notification of ionizing radiation sources and licensees.

The main goals of the national register are to provide a tool for the central registration of sources to register each licensee having any relation to the registered source, the registration of reports from the side of licensees, to provide an effective tool for inspectors of NSRCD. It also provides an overview of sources in the country and their actual status, information on the movement of sources, and identification in the case of abandoned sources.

In compliance with the NSRC Act and Rules, everyone who performs practices involving radiation is liable to keep a level of radiation protection so that the risk to human life, personal health and the environment is kept as low as reasonably achievable taking into account economic and social factors. All incidents in which radioactive materials are seized should be subject to continuing analyses.

3. ORIGIN OF SCRAP METAL IN BANGLADESH

The main origin of scrap metal in Bangladesh is ship breaking which is the process of dismantling an obsolete vessel's structure for scrapping or disposal. Conducted at a pier, dry dock or at a ship being dismantled, it includes a wide range of activities, from removal of all gears and equipment to cutting down the ship's infrastructure. Ship breaking activities are practiced in the coastal areas of Bangladesh and have gained importance in the macroeconomy and micro-economy of poverty stricken Bangladesh.

In Bangladesh, the ship breaking industry was born out of a severe cyclone in 1960. At that time, the Chittagong Steel House bought the Greek ship, *MD Alpine*, which was driven ashore by the devastating tidal storm at the Fauzdarhat seashore in Sitakunda Upazilla (Fig. 1), and scrapped it. After that, during the liberation war in 1971, the Pakistani ship *Al Abbas* was damaged by bombing. Later on, this was salvaged by a Soviet salvation team from Chittagong Port and brought to the Fauzdarhat seashore. In 1974, Karnafully Metal Works Ltd bought this as scrap, which is considered to be the beginning of commercial ship breaking in Bangladesh [5].

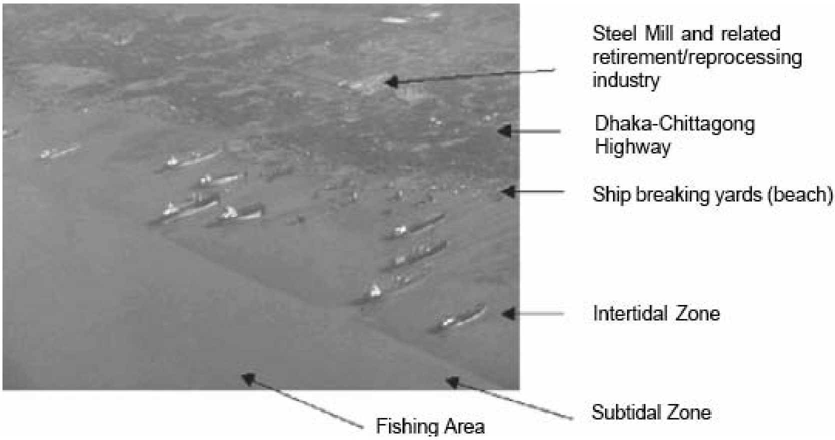

FIG. 1. Overview of the ship scrapping area of Chittagong [6].

Following these tentative beginnings, the ship breaking sector experienced a boom in the 1980s. As developed countries such as the United Kingdom, Spain, Scandinavian countries, Brazil, Taiwan Province of China and the Republic of Korea wanted to get rid of an industry, which was not in compliance with the new environmental protection standards, Bangladeshi industrialists, allured by huge profits, took the opportunities. Business people involved in the industry imported more and more ships, and Bangladesh gradually began to play a major role. As a result, within a short period, Bangladesh established a monopoly in the international market of big ship scrapping. Statistics show that about 52% of big ships are dismantled in Bangladesh (Fig. 2) [7].

The nature of Fauzdarhat to Kumira Coast offers many advantages making it particularly suitable for ship breaking, having:

— A long, flat uniform intertidal zone;
— An extended beach with a tidal difference of 6 m;
— Protection by the Bay of Bengal;
— Stable weather conditions;
— Low labour costs;
— Some existing infrastructure (being connected to the capital Dhaka by road and railway);
— Moderate enforcement of laws;
— A low level of environmental awareness;

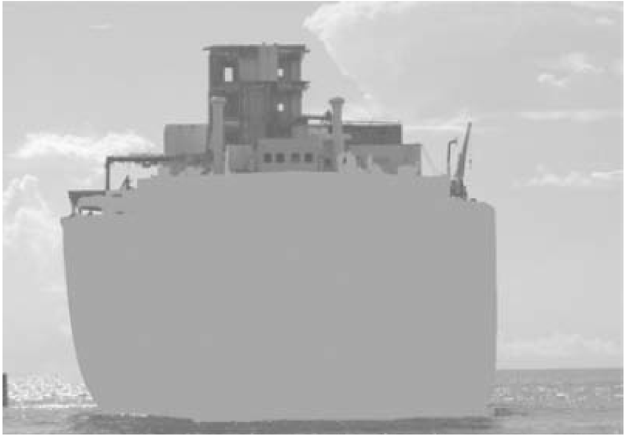

FIG. 2. About 52% of big ships from around the world are dismantled in Bangladesh [7].

— A huge demand for iron and steel in the local market;
— Rolling mills located nearby, which is an essential outlet for the steel of the dismantled ships.

Generally, 95% of a ship's body is made of mild steel (MS), 2% of stainless steel and 3% of miscellaneous metals, such as brass, aluminium, copper, gun metal and other alloys which are important factors in ship breaking [8]. Stores and other materials that may be available from a ship purchased for beaching are also considered to be very important. The contents of ship stores range from foodstuff to clothing, from electrical to electronic devices, most types of machinery, life saving equipment, drugs, communication equipment, etc.

Bangladesh does not have iron, as such, and has to depend on the scrapped iron to feed the rolling mills and steel factories. The main users of scrap irons are the local steel re-rolling mills that produce MS rods, MS bars, angles and steel sheets for the domestic market. The engines and generators are used by garment manufacturing factories; and boilers are used mainly in rice mills, garment washing plants, knitting plants and other industries. There is great demand for the wooden planks/bars and furniture which are sold at markets located in Chittagong and Dhaka.

Recently, as mentioned, the use of scrap metal imported from neighbouring countries has been increasing in Bangladesh as overall economic development activities increase.

4. NEED FOR ACTION

Ship breaking activities are being condemned as the whole process entails a series of risky tasks and creates a depot of hazardous substances, which pose threats to the ambient environment and the workers.

The following is a list of components on ships that potentially contain radioactive materials:

— Ionization chamber smoke detectors (ICSD) containing less than 37 kBq (1 μCi) of ^{241}Am might have been used in the cabins and engine rooms of the ships. During ship breaking, these detectors may be disposed of as general waste. In earlier models of ICSDs, the activity of Am could have been as high as 2.6 MBq (70 μCi);

— An 85 MBq (5 mCi) Co source is used nowadays for the detection of the level of pressurized liquefied CO gas in the portable fire fighting cylinders. In some ships, these types of cylinders might have been used and gone unnoticed by the ship breaker and thus may be included in general scrap for sale;

— Some of the ships would have been used for transporting radioactive material. If a package was not delivered to the consignee for some reason or other and remained on the ship, unnoticed by the checking authorities, this may form part of general scrap;

— In some warships, radiation detectors are installed for monitoring radiation during war periods. As part of a preventive maintenance programme, these detectors need to be checked from time to time with a reference source of radiation, normally 1.11 GBq (30 mCi) of ^{137}Cs. This may inadvertently be left in the ship and go unnoticed by the checking authorities before the ship is handed over for breaking;

— Density gauges incorporating about 1.11 GBq (30 mCi) of ^{137}Cs are used to measure on-line density of slurry during dredging operations. If these gauges are not uninstalled from the dredgers before the ship is released for breaking, they may form part of general scrap.

These radioactive materials subsequently become mixed with scrap metal destined for recycling. These events have the potential for having international consequences as well, for example, the transboundary transport of radioactive effluents from a mill that has an accidentally muted source or as the result of international marketing of mill products and by-products that have become contaminated.

Furthermore, as there is no training for workers in the dismantling process and no safety measures, these radioactive materials may be lost or stolen, or become abandoned. The subject of unauthorized use leading to illicit trafficking also constitutes a worldwide problem. Many accidental events have perhaps occurred but have not come to the attention of the authorities or cannot be confirmed.

5. ROLE OF THE BANGLADESH GOVERNMENT IN SCRAP METAL ACTIVITIES FROM SHIP BREAKING AND IMPORTED SCRAP METALS

A large number of ministries, departments and other government agencies are involved in the dismantling and recycling of ships. The Ministry of Ports, Shipping and Inland Water Transport Authority and the Ministry of Industries and Commerce are in command of the import and beaching of ships. The Department of Inspection for Factories and Establishment of the Ministry of Labour and Employment is responsible for registration of the yards as factories. In addition to that, the Department of Inspection also has responsibilities for ensuring occupational health and safety. The Department of Customs and border authorities are concerned with preventing the import or export of unauthorized and potentially hazardous material.

However, the regulatory authority for all aspects of radiation protection and nuclear safety in Bangladesh is less concerned with monitoring and the response to radioactive material in this scrap.

To create awareness, BAEC arranged a training workshop on radiation protection awareness for safe handling of radioactive contaminated scrap materials.

6. RECOMMENDATIONS

Recommendations on legal requirements to prevent nuclear illicit trafficking by scrap metals in Bangladesh include:

- The Chittagong Port authority should provide for the radiation monitoring of incoming and outgoing shipments of scrap metal;
- The port authority should confirm that owners of companies from which scrap metal shipments originate and buyer companies, before collecting the shipments from the ship, receive permission from BAEC to confirm that the scrap metal shipment has been checked for the presence of radioactive materials.

The main source of scrap metal in Bangladesh is ship breaking yards. Scrapping and scrap handling are performed simultaneously in these yards almost all year round. The workshop imposed more recommendations on this sector:

— During the application process for receiving beaching permission along with other types of permission, it is necessary to provide a copy of a permission letter from BAEC;
— The ship should be thoroughly checked by explosive and customs authorities before it is cleared for breaking, and items containing radioactive materials should be removed before beaching;
— Under the NSRC Act of 1993 and the Rules of 1997, there should be provision for inspection of the ship before beaching and preparation of a complete inventory of equipment containing radioactive materials;
— In Bangladesh, the Mercantile Marine Department conducts surveys to check safety measures taken and also checks marine stores and prepares a list. With Marine Department surveyors, a survey can be done of equipment containing radioactive materials by BAEC. The Mercantile Marine Department should procure radiation survey meters (low range and medium range) for radiation monitoring and detection;
— Ships due for breaking may be misused by some countries for the disposal of radioactive waste in Bangladesh. If radioactive material exists, it should be disposed of before the ship is beached for breaking. To control this probable illegal activity, customs and other concerned authorities need to be involved to take care of such cases;
— BAEC should prepare safety instructions on the handling and disposal procedures of items containing radioactive material that should be circulated to all shipyard owners so that no radioactive material goes into the scrap as normal waste;
— A recommendation should be provided to sellers, buyers, national customs and border authorities. The authorities, especially Chittagong Port authority and ship breaking enterprises, should establish agreements with BAEC for the provision of advice and training on the detection of radionuclides in scrap metal and the response procedure;
— To mitigate the problems regarding illicit trafficking of nuclear materials through scrap metal and the associated environmental impacts, cooperation and collaboration between scientists, policy makers, owners, local representatives, NGOs, media and different stakeholders must be achieved through consultation, seminars, workshops, discussions, etc.;
— For sustainable monitoring and response procedures for radioactive scrap metal, a link between international organizations and NGOs, interagency

cooperation and strengthening capacity building of the relevant Government departments through training is a must.

7. CONCLUSION

Incomplete rules and regulations concerning operator functions and responsibilities, including the requirements for internal control, quality assurance, security culture and individual responsibilities; lack of technical capacities of customs checkpoints, shortage of staff and training capabilities and insufficient financial resources concerning supervision and law enforcement authorities is missing in scrap metal monitoring and response in Bangladesh. The national authorities are trying to mitigate this gap and to reduce the probability of illicit trafficking.

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MAIN COMPONENTS OF THE POLISH SYSTEM FOR COMBATING ILLICIT TRAFFICKING — NATIONAL ATOMIC ENERGY AGENCY PERSPECTIVE

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Abstract

The paper presents the main components of the Polish system for combating illicit trafficking. The topics covered include a description of the legislative framework (both at the national and international level) as well as individual tasks and the interdependence of different institutions involved in this subject.

1. LEGISLATIVE FRAMEWORK

The Polish law regarding nuclear safety, radiation protection and the control of radioactive sources and nuclear materials is designed according to recommendations and guidelines published by the European Commission, the IAEA and other requirements established in international conventions and agreements in force in Poland. Poland is party to the following international undertakings in this field:

- Treaties and conventions: Treaty on the Non-Proliferation of Nuclear Weapons (with Comprehensive Safeguards Agreement and Additional Protocol in force); Convention on the Physical Protection of Nuclear Material; Convention on Early Notification of a Nuclear Accident; European Agreement concerning the International Carriage of Dangerous Goods by Road;
- Export control regimes: Nuclear Suppliers Group; Zangger Committee;
- Information exchange systems: Illicit Trafficking Database (ITDB); European Community Urgent Radiological Information Exchange (ECURIE); Early Notification and Assistance Conventions web site (ENAC).

The most important national legal instrument in matters connected with nuclear and radiological security and safety is the Act of Parliament of 29 November 2000 — Atomic Law (with later amendments). This document (and supporting regulations issued by the council of ministers) specifies the obligations and rights of the president of the National Atomic Energy Agency (NAEA) who “constitutes the central organ of the governmental administration, competent for nuclear safety and radiological protection matters” (Art. 109 of Atomic Law). Among other things, his duties are:

— Issuing of licences for manufacturing, processing, storage, disposal, transport or use of nuclear materials, radioactive sources, radioactive waste and spent nuclear fuel, as well as the trade in these materials (Art. 4.1 of Atomic Law);
— Coordination of the fulfilment of obligations of Poland regarding nuclear materials safeguards and nuclear technology control and maintenance of the national system for gathering and processing data allowing the quantitative inventory balance of source materials and special fissile materials in the country to be kept (Art. 41a of Atomic Law);
— Keeping the register of high activity sources and of other sealed radioactive sources used and stored in organizational entities which conduct licensed activities (Art. 43c of Atomic Law);
— Conducting systematic assessments of the national radiation situation (Art. 72.1 of Atomic Law).

Implementation of those tasks is the responsibility of different departments of the NAEA and will be described more precisely in subsequent parts of this paper. The structure of the NAEA is shown in Fig. 1.

Other important regulations from the point of view of combating illicit trafficking are two Acts of Parliament, defining the scope of activities of the border guard and customs service (Parliamentary Act of 12 October 1990 on Border Guards and Parliamentary Act of 24 July 1999 on the Customs Service — both with later amendments) and the regulation of the chief commander of the border guard of 23 March 2006, describing the procedure of control of transports crossing the national border. Moreover, there are bilateral agreements signed by the president of the NAEA, the chief commander of the border guard (amended on 19 August 2005) and the head of the main office of customs (signed on 7 January 1998). These agreements regulate questions of training of personnel; and identification, evaluation, information exchange and cooperation regarding detected suspicious and undocumented goods.

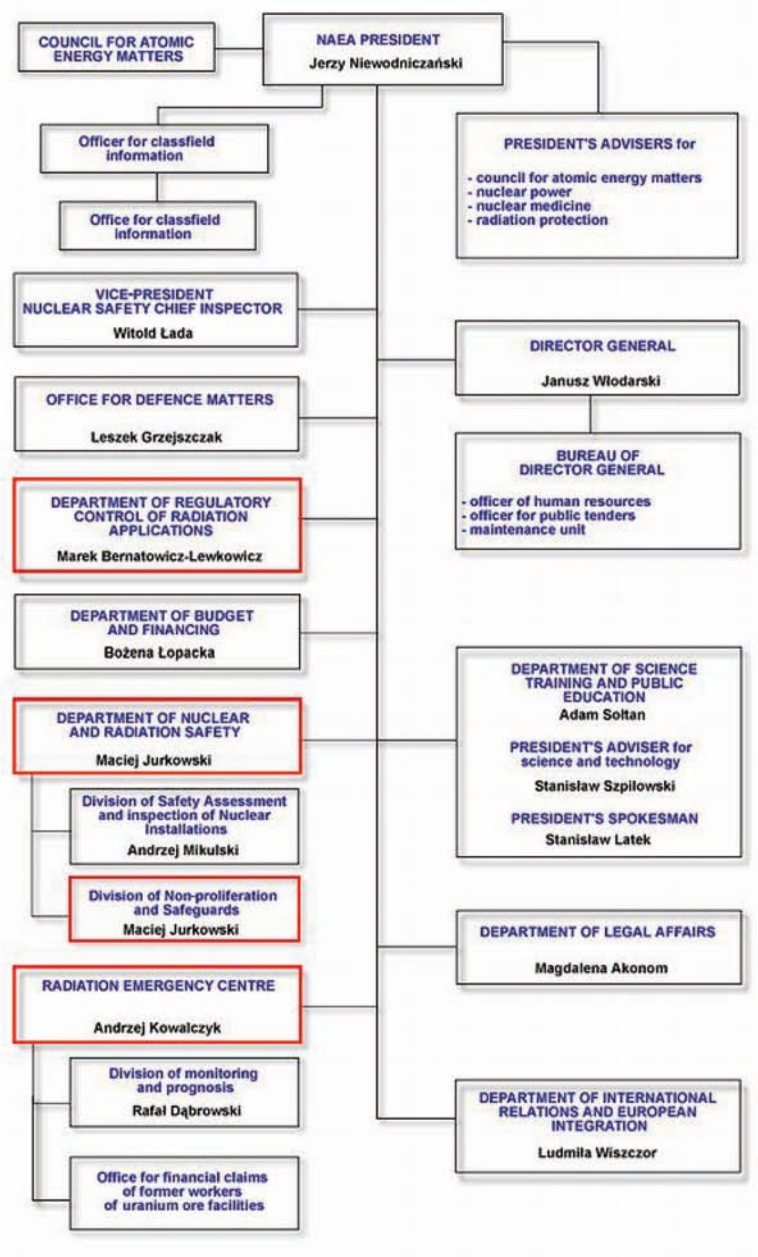

FIG. 1. Organizational structure of the National Atomic Energy Agency (NAEA) — departments of special importance for combating illicit trafficking are marked with red frames.

2. ACCOUNTANCY AND CONTROL OF RADIOACTIVE SOURCES AND NUCLEAR MATERIALS

The collecting and processing of data essential for keeping central national registries of radioactive sources and nuclear materials is the responsibility of two different cells within the structure of the NAEA.

2.1. Non-proliferation division

The non-proliferation division is part of the Department of Radiation and Nuclear Safety. This section serves as the State system of accountancy and control of nuclear materials. Based on reports received from nuclear material holders, the central registry is updated. Every report is checked from the point of view of discrepancies (e.g. differences between shipper and receiver data). Regulatory inspectors employed in the non-proliferation division conduct inspections in order to check the consistence of physical and book inventories; special inspections are also conducted if necessary (e.g. in case of receipt of fresh fuel by the MARIA research reactor). The type of information describing each batch of material is compatible with requirements of the European Commission and the IAEA. The non-proliferation division also prepares nuclear materials accountancy (NMA) reports, i.e. physical inventory listings (PILs), inventory change reports (ICRs) and material balance reports (MBRs), for the European Commission in the name of MBA grouping small holders of nuclear materials — WPLE.

Another type of inspection conducted by experts from the Department of Radiation and Nuclear Safety (often supported by the Office for Defence Matters) concerns the implementation and design of physical protection systems of nuclear installations. The detailed description of such systems must be approved by the president of the NAEA.

The next two important duties of the non-proliferation division are performing the role of the national contact point of the Illicit Trafficking Database and taking part (as an advisory body) in the State system of granting export authorization of dual use and dangerous goods.

2.2. Department of Regulatory Control of Radiation Applications

A similar system as for nuclear materials is in place for radioactive sources. Holders of sources are obliged to send updated inventories of possessed sources annually to the Department of Regulatory Control of Radiation Applications which keeps a central registry of sources. The received information (e.g. name of isotope, activity, type of source) is verified from the point of view of the inspection's observations and conditions of licence. The central registry contains information not only about the current owner of the source but also about source movements in the past and previous owners. Moreover, information about sources sent to the national radioactive waste repository is kept. In total, data on about 17 017 sources (including those withdrawn from operation) is kept — status on 31 December 2006.

3. RADIATION EMERGENCY CENTRE (CEZAR)

CEZAR is a separate cell in the NAEA structure responsible for:

— Collecting, verifying and analysing data from radiation monitoring stations, allowing for assessment of the radiation situation in Poland;
— Establishing a national contact point (working a 24/7 regime) for radiation emergency information exchange systems such as ECURIE and ENAC;
— Providing expertise in all cases of potential radiation emergencies — this task is of special importance from the point of view of border guards working on border checkpoints equipped with radiation detection portals.

According to the contract signed by the president of the NAEA and the director of the Radioactive Waste Management Plant (RWMP), the latter institution provides the services of an emergency dosimetric team. In case radioactive, contaminated or nuclear material is detected, CEZAR's officer on duty has the authority to give an order of departure to the RWMP team which travels to the indicated location and conducts the necessary measurements to assess the radiation hazard, identify material and (if appropriate) collect material and transport it for further analysis or for disposal. In 2006, there were 22 events that qualified as radiation emergencies and six of them required the departure of the RWMP team. In addition, CEZAR officers on duty provided about 2000 consultations — most of them were connected with alarms triggered by radiation detection portals at border checkpoints.

4. RADIATION DETECTION EQUIPMENT AT BORDER CROSSINGS AND AIRPORTS

The total length of Poland's borders is approximately 3500 km of which almost one half is an external European Union border. As of 1 January 2007, 214 border checkpoints were equipped with radiation portal monitors with gamma or gamma–neutron detection capabilities. These portals are used to detect radioactive and nuclear materials in the means of transport, at pedestrian crossings points, in transported cargo and in hand luggage. Detection equipment is installed in a configuration that does not disturb traffic. When an increased level of radiation triggers an alarm, the vehicle (or person) is stopped for further careful examination with handheld radionuclide identification devices and radiation detectors. The procedure for this examination was established in Annex 3 of the regulation of the chief commander of the border guard of 23 March 2006. The procedure states that in cases of suspicious distribution of radiation, a high level of radiation or discrepancies between measurements and transport documents, the border guard will contact CEZAR and ask for an expert opinion and further recommendations. If necessary, the radioactive object can be separated and later on collected by the RWMP team as described in Section 3 of this paper.

5. CONCLUSIONS

As described, Poland has implemented a comprehensive and effective system for combating illicit trafficking of radioactive and nuclear materials. This system can be divided into three components: a legislative framework, competent organizations and equipment. All three of these components allow our national system to fulfil three main goals: prevention, detection, and response to undesirable actions involving nuclear and radioactive materials.

National legislation designed in accordance with guidelines and recommendations of the international community covers all essential issues, such as licensing of import, export and operation of radioactive and nuclear materials; keeping central national registries of both materials and users; establishing means of information exchange with other States and international organizations.

Two organizations contribute substantially to the national system for combating illicit trafficking: (1) the border guard, working as a first line of defence at border crossings, airports and harbours; and (2) the NAEA, being the regulatory authority in all matters connected with radiation protection, nuclear safety and security. Close cooperation between these two bodies is essential for efficient operation of the system. Only the combination of equipment and operational capabilities of the border guards with expertise from the NAEA professionals can assure appropriate protection of Polish and European borders.

The radiation detection equipment used at Polish borders is constantly upgraded. All border crossings are fitted out with gamma detection devices and most of them also have neutron detection capabilities. Proper detection of adverse acts is achieved by the combined use of portal monitors and handheld instruments.

IAEA-CN-154/053P

DEFENCE AGAINST NUCLEAR HAZARDS IN GERMANY — THE FEDERAL APPROACH

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Abstract

The defence against nuclear hazards deals with the abuse of nuclear material and orphan radioactive sources. In Germany, this task is handled by the federal states. In the case of an emergency with nuclear material or an attack with a radiological weapon, the state concerned can call on the Federal Government for additional forces to cope with the situation. Specialists from the Federal Criminal Police, the Federal Office for Radiation Protection and the Federal Police will then be integrated into the local task force dealing with the threat. At any given time, control of the operation remains in the hands of the local police administration. Experience so far shows that it is crucial for federal forces to retain a high degree of flexibility. This was especially proven in dealing with the ^{210}Po contamination in Hamburg.

1. INTRODUCTION

This contribution will give an outline of German efforts to combat the abuse of nuclear materials with special regard to the federal structure of Germany. The defence against nuclear hazards deals with the abuse of nuclear material and orphan radioactive sources. In Germany, this task is handled by the federal states (Fig. 1). Therefore, German hazard defence is a joint effort of the federal states coordinated by the Federal Government. The federal states and Government serve in terms of IAEA Safety Standards [1, 2] as the ‘national coordinating authority’.

2. EMERGENCY RESPONSE

In the case of a serious emergency with nuclear material or an attack with a radiological weapon, the concerned state can apply for help from the Federal Government in the form of additional forces to deal with the situation.

FIG. 1. The 16 federal states of Germany; each has its own regulations, police, task force against hazards, etc.

However, if no support from the Federal Government is requested, none will (or can) arrive. No intervention from the Federal Government takes place without the consent of a regional government and the local forces will retain control of the operation. The Federal Government will be informed by the local authorities, though, and will communicate all necessary facts to international organizations.

If a request for assistance is filed, the Federal Government will have to decide what kind of support it will grant, if any. In a less significant case, the support might be limited to assistance with international contacts or equipment and advice from specialists. If the decision to send additional personnel is made, specialists of the Federal Criminal Police (BKA), the Federal Office for Radiation Protection (BfS) and the Federal Police (BPol) will be integrated into the task force already dealing with the threat. The federal state will provide for the basic needs of its personnel, such as accommodation, meeting rooms, supplies, etc.

At any given time, control of the operation remains in the hands of the regional police administration. Federal workers (police, radiological specialists) have to take orders from the leader of the local police. The chain of command is preserved at all times. Federal forces are not authorized to execute the normal duties of local authorities, such as clearing an area for public use. For example, the examination of ^{210}Po contamination in Hamburg was conducted by federal radiological experts. Nevertheless, the sites could only be cleared by regional authorities [3].

3. SYSTEM CHARACTERISTICS

The characteristics of federal nuclear and radiological emergency support personnel are largely determined by the federal system. Since every federal state has different ways of dealing with nuclear hazards, different regulations and specialists, it is crucial for federal forces to retain a high degree of flexibility and the ability to integrate into any given local environment.

Although this structure of German defence against hazards is solely given by the constitution, it offers some advantages:

- The need for a joint threat assessment (as postulated in Ref. [2]) is acknowledged by all authorities concerned with the emergency response, so information is readily distributed between the organizations working on defence against hazards;
- The responsibility for dealing with a threat lies in the same hands for the whole operation [4]. The chain of command is preserved at all times and is well known to all organizations;
- The overall response time of police forces and radiation specialists is minimized. Federal specialists can be mobilized while local and regional forces are already gathering information about the incident. The staff of local police will automatically distribute all necessary information for combined forces;
- Regional police forces have good knowledge of infrastructure, local laboratories and other sites;
- This is especially useful when samples are to be taken and analysed;
- States save time, money and personnel by relying on specialists of the federal offices for tasks with a low order probability of occurrence;
- It is easily possible to hand over control of an incident to disaster control authorities of the federal state(s) if needed.

There are some disadvantages of the decentralized structure:

— Federal forces have to adapt to 16 different structures and regulations. It takes time for new personnel to integrate and work efficiently (see Table 1 for an example);
— The number of regional forces is heavily dependent on special sites as defined in Ref. [1] (e.g. nuclear power plants, nuclear research sites, chemical factories). While for some states only minimal support with highly specialized tasks is necessary, others need help with rather basic tasks in the case of a radiological emergency;
— Slow cooperation of local forces can complicate the integration of federal experts;
— Functionality of the system can only be ensured through regular exercises at the federal and regional level;
— Failure to communicate changes in threat assessment could cripple the hazard defence in a short period of time.

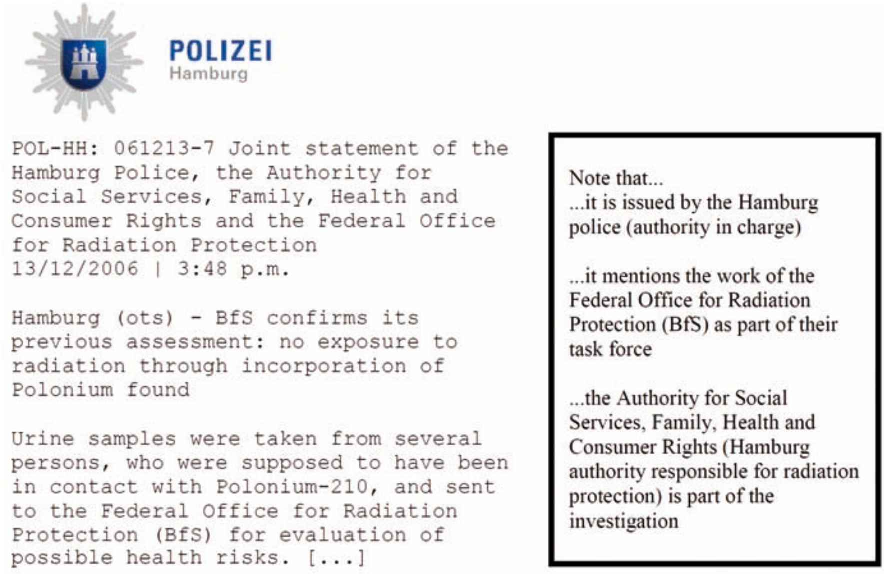
4. EXPERIENCES

The ability of the states to handle incidents with nuclear material of minor importance on their own is proven on a regular basis. Experience in the field of cooperation with federal forces has been made at exercises of combined forces, cooperation during the FIFA World Cup 2006 and the handling of ^{210}Po contamination in Hamburg. In the latter case, it is worth noting that the combined task force of federal and local personnel was commissioned and working within hours after the call for assistance (Fig. 2).

The modular structure of the task force in Hamburg proved to be helpful for the integration of federal forces and also for those from the second state affected (Schleswig-Holstein), fire departments and disaster control authorities.

TABLE 1. JURISDICTION OF HAZARD DEFENCE IN TWO DIFFERENT FEDERAL STATES

Federal state	Responsible authority	Regulations
Mecklenburg-Vorpommern	Ministry of the Interior	On the basis of Nuclear Law [5]
North-Rhine Westphalia	Ministry of Labour, Health and Social Services	"The Nuclear Law [5] and the Radiation Protection Law provide no regulations for defence of Nuclear Hazards." (definition of regulations on the basis of police law)


POLIZEI
Hamburg

POL-HH: 061213-7 Joint statement of the Hamburg Police, the Authority for Social Services, Family, Health and Consumer Rights and the Federal Office for Radiation Protection
13/12/2006 | 3:48 p.m.

Hamburg (ots) - BfS confirms its previous assessment: no exposure to radiation through incorporation of Polonium found

Urine samples were taken from several persons, who were supposed to have been in contact with Polonium-210, and sent to the Federal Office for Radiation Protection (BfS) for evaluation of possible health risks. [...]

Note that...
...it is issued by the Hamburg police (authority in charge)

...it mentions the work of the Federal Office for Radiation Protection (BfS) as part of their task force

...the Authority for Social Services, Family, Health and Consumer Rights (Hamburg authority responsible for radiation protection) is part of the investigation

FIG. 2. Translation of a joint press release from the ^{210}Po contamination in Hamburg [4].

Numerous other authorities were also prepared to integrate in a similar way. Additionally, this incident demonstrated the importance of a unified communication structure. All involved are continually working on optimized future procedures.

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TECHNICAL METHODS AND STRATEGIC MEASURES TO COUNTERACT THREAT SCENARIOS INVOLVING RADIOACTIVE MATERIALS

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Abstract

In line with the different types of radiological hazards emerging from radioactive substances (external exposure due to gamma and neutron radiation, internal exposure due to inhalation and internal exposure due to ingestion), three main categories of threat scenarios are distinguished: (1) dirty bomb scenarios with hazards emerging from external exposure to direct radiation and internal exposure due to inhalation of radioactive aerosols; (2) ingestion scenarios of isotopes with weak or no gamma radiation; (3) inhalation scenarios without explosives. Each scenario category affords close collaboration of law enforcement authorities and radiation protection experts, but different measuring strategies and different technical equipment. The typical strategies for the prevention of radiological hazards and the measuring devices which can be used to fulfil this task are described for each of the three categories.

1. INTRODUCTION

Radiological hazards emerging from the criminal or terrorist use of radioactive materials are due to the following three exposure paths:

— External exposure to direct radiation;
— Internal exposure due to inhalation;
— Internal exposure due to ingestion.

In order to be able to develop successful strategies to combat these hazards, three different classes of threat scenarios have to be considered:

(a) *Dirty bomb scenarios:* In the last decade of the last century, the law enforcement authorities of many countries mainly prepared themselves to combat threat scenarios where radioactive material is intended to be distributed by means of a radioactive dispersion device (RDD), also called a ‘dirty bomb’ within a limited area (up to several km^2). To ensure the maximum radiological hazard for the public, it is suspected that perpetrators will use isotopes that emit not only alpha or beta radiation but also gamma or neutron radiation. In these scenarios, the radiological hazards originate from both external exposure and internal exposure due to the inhalation of radioactive substances;

(b) *Ingestion scenarios of isotopes with weak or no gamma radiation:* The incidents resulting from the poisoning of the former KGB agent Litvinenko and the ^{210}Po contamination in Hamburg, Germany, demonstrate the importance of considering additional scenarios where a large number of people can be harmed or even killed by intentional contamination of the public’s food and drinking water supply;

(c) *Inhalation scenarios without explosives:* Special scenarios to be considered in this category are the contamination of ventilation installations of public buildings with radioactive material or the distribution of radioactive aerosols over a large area.

For all these scenarios, the main goal of law enforcement authorities has to be to identify and to arrest the potential perpetrators before they can carry out an unlawful act. Nevertheless, each kind of scenario affords a different approach to preventive and tactical measures as well as to the measuring techniques and measuring systems to be applied.

2. DIRTY BOMB SCENARIOS

In these scenarios, the immediate deadly danger for most of the people concerned results not from the radioactive supplement but from the explosive itself. As has been reported by Egger et al. [1], the additional dimension of damage is due to the contamination of several km^2 with long lived radioactive isotopes. If that were to happen in the centre of a city, the costs for decontamination of the infrastructure and for the evacuation of the inhabitants of the area, and resulting from that the economic losses, could amount to several billon euros.

Because the main hazards result from conventional explosives, the strategies for combating the threat from these scenarios in Germany have emerged from the classical actions taken to solve conventional terrorist bomb scenarios.

In the last few years, the focus was on training the police forces for adequate behaviour in the vicinity of radioactive materials and on the integration of technical, radiation protection and gamma spectroscopy experts into the police task force, thus multiplying the skills of the emergency teams. In addition, many detection and hazard prevention strategies were developed by the close cooperation of German law enforcement authorities and radiation protection authorities.

The main task of the emergency teams is to find and secure the radioactive material before the perpetrators ignite the RDD. Due to the short range of alpha and beta particles, only radionuclides emitting sufficiently long range gamma or neutron radiation can be detected and localized from a larger distance. Such radionuclides lead to additional hazards emerging from an RDD due to external exposure.

To be able to detect and localize the radioactive material needed for an RDD within a larger area, most attention is focused on measuring systems incorporating large volume scintillation and ^{3}He neutron detectors for search by car. One of these systems allows real time nuclide identification by large NaI detectors during the search. A combined detection system consisting of a scintillation detector and a ^{3}He neutron detector will be used for the covert search on foot by specially trained observation teams.

A conventional open search can also be performed with a large number of small handheld scintillation detectors.

After localization of the RDD, the device has to be investigated by the bomb disposal unit in close collaboration with gamma spectroscopy experts to estimate the amount of explosive, the kind of igniter and the type of isotopes and, if possible, the activity of each isotope involved.

For the 'quick and dirty' identification of radionuclides, compact spectrometers with NaI detectors are used. The NaI detectors will be successively exchanged with $LaBr_3$ detectors that provide twice the energy resolution. A more exact nuclide identification (in the case of a complex spectrum or if multiple isotopes are present), as well as the activity estimation of the nuclides inside an RDD, is achieved by high resolution gamma spectrometers with Ge detectors. To identify the isotopic composition of plutonium and uranium, a special gamma spectroscopy system (including a high resolution planar n-type Ge detector and a special nuclide identification software) is used.

In the case of an explosion of a dirty bomb, radionuclides are expected to be released into the atmosphere and to become dispersed. This leads to an additional threat due to inhalation. The committed dose depends on the kind of isotopes and their activity concentration in the inhalation airflow and the time spent inside the radioactive cloud. Atmospheric distribution models have been developed to calculate the spatial and chronological development of the activity concentrations and as a result the inhalation dose. For the reliable prediction of these concentrations, the source term is needed. Every effort should be made, therefore, to estimate the activities of all isotopes involved by, for example, gamma spectrometric measurements at the site of the object under suspicion before its possible explosion.

If there is a suspicion that open radioactive substances are involved, all members of the action teams concerned have to be controlled for contamination with the help of alpha, beta and gamma contamination probes. In the case of contamination, the affected persons will be decontaminated in nearby mobile installations and afterwards checked for incorporation using a whole body counter or by excretion analyses.

Finally, after arresting the suspects, defusing the RDD and securing the radioactive material, the site is handed over to crime scene experts. Instructions on how to act at such a crime scene have been developed and the first on scene training sessions have been performed in close collaboration with police and technical experts. Technical experts support the crime scene experts in finding additional hidden radioactive sources and check pieces of evidence for radioactive contamination. In addition, they provide support in all radiation protection matters.

3. INGESTION SCENARIOS OF ISOTOPES WITH WEAK OR NO GAMMA RADIATION

In contrast to dirty bomb scenarios involving gamma and neutron radiation, the threat caused by external radiation from mainly alpha or beta emitting radionuclides is minute. The main radiological hazard will evolve from the ingestion and/or inhalation of the radioactive substances.

In the case of a criminal act where alpha emitting isotopes with large radiotoxicity (many of them without a strong gamma component, e.g. ^{210}Po) are utilized, only small activities are necessary to apply a lethal dose. Such radionuclides are not detectable by the measuring techniques used for dirty bomb scenarios to localize and to identify the radioactive sources expected to be used in an RDD. Therefore, from our point of view, a shift of the measuring procedure from a large area search and localization of distinct small volume sources to a more laboratory based measuring procedure will be necessary so that radioactive substances can be identified by means of the emitted alpha and beta radiation or low level gamma radiation via spectroscopy. To be able to respond as fast as possible to such threats, fast initial analyses are necessary. For that purpose, samples of the material under suspicion, or excretion samples when the suspicion of incorporation arises, have to be analysed in a specialized laboratory with adequate equipment. Low level gamma spectrometers, alpha spectrometers and beta spectrometers including liquid scintillation detectors should be present. From such analyses, incorporated activities or activity concentrations in food or drinking water can be estimated.

Possible victims are checked for skin contamination and decontaminated if necessary. Eventually, they will be hospitalized for further investigation and medical treatment.

In these scenarios, the detection of radioactive isotopes by technical means is much more difficult and, therefore, the detective and investigation work of the law enforcement authorities is even more important in order to localize and seize the radioactive substances before a terrorist strike can be executed. The support which can be given by the technical and radiation protection experts is to conduct random tests of drinking water and food at the endangered sites. Furthermore, they will check the crime scene and other places under suspicion of contamination.

In contrast to the dirty bomb scenarios, the most affected action team after such a criminal act has been carried out will most likely be the crime scene team with the support of technical experts. Therefore, training their collaboration at different crime scenes will be one of the most important tasks in the near future.

4. INHALATION SCENARIOS WITHOUT EXPLOSIVES

In order to apply a high inhalation dose to many people, the distribution of dispersable radioactive substances via the ventilation installations of public buildings is much more effective than using a dirty bomb. For example, small amounts of reactor plutonium (less than 10 g), if homogenously distributed as respirable particles within an air volume of 10 000 m^3, would lead to a lethal effective 50 dose if adult victims were to stay for 1 h in the contaminated air. Despite the emission of gamma and neutron radiation, such small amounts of plutonium can hardly be detected from distances larger than 1 m by gamma or neutron probes. Therefore, in this kind of scenario, the detective and investigation work of the law enforcement authorities to localize and seize the radioactive substances before a terrorist strike can be executed is as important as in the ingestion scenarios described above.

Nevertheless, there might be scenarios where isotopes with strong gamma components or neutron emitters are used. In these cases, the search for such sources with large volume scintillation and neutron detectors before the assault has been executed could be successful.

If information about the endangered buildings has become available, they have to be evacuated and closed. To check for possible contamination, or, if the radioactive material has already been distributed, a decontamination area with

TABLE 1. OVERVIEW OF THE THREE KINDS OF CONTAMINATION SCENARIOS

Scenarios	Dirty bomb	Ingestion	Inhalation without explosive
Radiological hazards	External exposure by: — γ radiation; — Neutron radiation Internal exposure by: — Inhalation	Internal exposure by: — Ingestion and internal α and β radiation	Internal exposure by: — Inhalation and internal α and β radiation
Measurement strategies and typical equipment	Open or covert search by car with: — Large volume scintillation detectors; — Large volume ^{3}He neutron detectors Open or covert search on foot with: — Handheld scintillation and neutron detectors First isotope identification with: — γ spectrometer with NaI or $LaBr_3$ detectors Isotope identification and activity estimation with: — High resolution γ spectrometer with Ge detectors Isotopic composition of U and Pu with: — N-type HPGe detectors and special analysis software Contamination control with: — Contamination probes	Analysis of random test samples, wipe test samples and excretion samples with: — α spectrometry systems; — Liquid scintillation detectors for beta counting; — Low level γ spectrometers; — Wipe test measuring stations Analysis of contaminated sites with: — Calibrated contamination probes Contamination control and external decontamination in: — Decontamination installations	Search for radioactive material with: — Large volume scintillation and neutron detectors Taking of filter samples of the inspiration airflow with: — Air sampling devices Analysis of filter and samples with: — Wipe test measuring stations Analysis of excretion samples with: — α spectrometry systems; — Liquid scintillation detectors for beta counting; — Low level γ spectrometers Analysis of contaminated sites with: — Calibrated contamination probes Contamination control and external decontamination in: — Decontamination installations

appropriate installations and trained personnel (including experts in radiation medicine) will be installed close to the building concerned. After decontamination, the people who are suspected of having inhaled radioactive substances have to be investigated and treated in special radiological hospitals.

For the calculation of the inhalation dose of affected people, the activity concentration of the utilized radionuclide in the inhalation airflow, as well as its chemical and metabolic properties are decisive. For this purpose, the activity concentration in the inspiration airflow has to be estimated. Radioactive aerosols are sampled by mobile aerosol sampling devices and analysed by alpha, beta and gamma spectroscopy. If radionuclides emitting gamma radiation were used, the inhaled activity can be determined by body counters. The inhalation dose can be calculated from these results.

5. SUMMARY

Three different kinds of radiological threat scenarios have to be considered:

— Dirty bomb scenarios with the main radiological hazards due to external exposure and inhalation of radioactive substances;
— Ingestion scenarios of isotopes with weak or no gamma radiation;
— Inhalation scenarios without explosives with the main radiological hazards due to inhalation of radioactive substances.

These three kinds of scenarios afford different strategic means and different measurement equipment. A compact overview is given in Table 1.

In the real world, what the scenarios emergency services, law enforcement agencies and governments will have to account for will be a mixture of the three kind of scenarios described. It should be noted that the particular scenario will develop in an unforeseen direction, and the strategies and technical equipment will have to be adjusted to the particular situation.

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IAEA-CN-154/063P

NATIONAL EFFORTS TO COMBAT ILLICIT NUCLEAR TRAFFICKING

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Abstract

The Office of Atoms for Peace has organized national training courses on radiation monitoring of nuclear and radioactive material in order to combat illicit nuclear trafficking by using simple national made instruments. The participants are the customs, border control, frontline officers, intelligence agency, seaport and airport authority, forensic police, and disaster prevention and mitigation officers. The main objectives of the courses are to provide a basic understanding of radiation safety, radiation monitoring, etc. Simple radiation detectors were provided for the responsible officers.

1. INTRODUCTION

United Nations Security Council Resolution 1540 requires that all States develop and maintain appropriate effective border controls and law enforcement efforts to detect, deter, prevent, and combat illicit trafficking and brokering in nuclear weapons, and also to implement national export and trans-shipment controls over such items. The Office of Atoms for Peace has been designated by the National Security Council to prevent proliferation of nuclear weapons and radiological dispersal devices. Therefore, the national training courses on radiation monitoring of nuclear and radioactive material using simple national made instruments have been routinely organized for the customs, border control, frontline officers, intelligence agency, seaport and airport authority, forensic police, and disaster prevention and mitigation officers. The main objectives of the courses are to provide basic understanding regarding radiation safety and nuclear security to the officers. The national efforts via proper trainings will enable responsible officers to secure and prevent illicit nuclear trafficking at the national borders through the installation of national made radiation detection equipment. This will also ensure that relevant officers will be adequately protected from possible radiation hazards caused by nuclear and radioactive materials when they deal with illicit trafficking.

2. DESCRIPTION OF THE COURSE

The IAEA training courses such as the regional training course on combating illicit trafficking of nuclear and other radioactive material, the subregional workshop on illicit nuclear trafficking information management and coordination, the regional training course on response to criminal or unauthorized acts involving nuclear or other radioactive materials, the regional training course on advanced detection equipment, etc., have been modified to suit the national need. The course consists of:

- Radiation principles, overview of radiation principles including atoms, alpha, beta, gamma and neutron radiation, isotopes;
- Issues involving health and safety when radioactive materials are discovered (health effects of radiation, ALARA principle including time, distance and shielding);
- National legal framework for nuclear security;
- Application of radioactive sources in health, medicine and industry;
- Introduction to radiation detection instruments and overview of the different types of instrument;
- Sustainability of radiation detection equipment, presentation on element to consider the deployment and continued operation of radiation detection equipment;
- Standard practice for radiological incidents;
- Exercises on radiation detection, radiation monitoring, radiation protection, radioactive sources searching exercise;
- Video presentation on the transport of radioactive and nuclear material, Georgia 2002 and nuclear weapons;
- Course evaluation.

3. CONCLUSION

Thailand is deeply concerned about nuclear terrorism and the proliferation of nuclear materials, and recognizes the responsibility it has to control the unauthorized movement of these materials. Efforts are being made to secure the national borders through the installation of radiation detection equipment. It will also be ensured that frontline officers have adequate training and full support to protect themselves when dealing with nuclear and radioactive materials. One of the efforts is to provide the knowledge and simple radiation detection equipment for detecting and characterizing illicitly trafficked material. The results of the participants from customs, border control, frontline officers, the intelligence agency, the seaport and airport authority, forensic police, and disaster prevention and mitigation officers are shown in Figs 1 and 2.

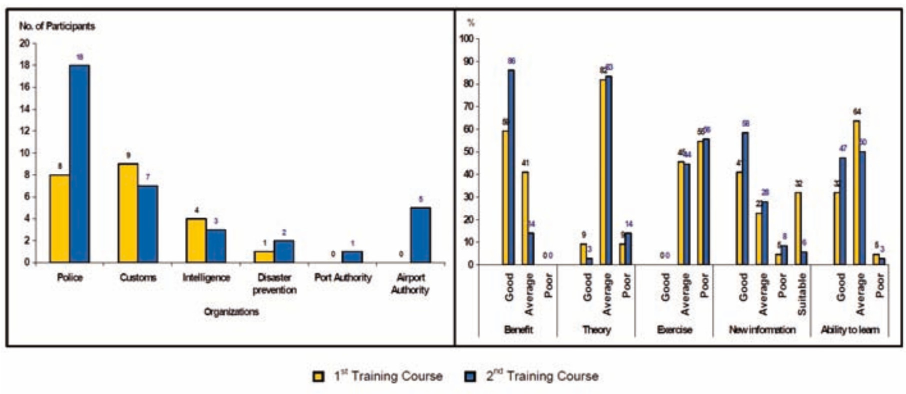

FIG. 1. *Number of participants from relevant organizations.*

FIG. 2. *Evaluation of the participants' understanding.*

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IAEA-CN-154/064P

STATE OF THE ART IN HIGH PURITY GERMANIUM SYSTEMS FOR HOMELAND SECURITY APPLICATIONS

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Abstract

The IAEA initiated the Coordinated Research Project Improvement of Technical Measures to Detect and Respond to Illicit Trafficking of Nuclear and other Radioactive Materials in April 2002. The resultant reference manual was published in March 2006. In response to the needs expressed by the IAEA, ORTEC developed the Detective line of high purity germanium (HPGe) radioisotope identifiers (RIIDs). These are now well known and widely used. Several hundred are deployed worldwide in interdiction. The technology used in the Detective has been further developed to address two additional threat interdiction requirements. In the first, a smaller, lighter weight Detective-like device was developed by ORTEC and adapted to meet the needs of the US Human Portable Radiation Detection Systems (HPRDS) programme. The commercial version of this new instrument will be available in January 2008. The development programme and the new product are described. The second advancement is the broadening of the scope of the technology to address new applications for spectroscopic portal monitors as well as wide area search systems. ORTEC has developed modular hardware and software for use in a variety of portal and other configurations. In addition, a software model has been developed to predict portal performance in a variety of detectors and detector placement in these configurations. The hardware and software are described, and performance model data presented and compared to measurements in a pedestrian portal.

1. A SMALLER DETECTIVE

The original Detective was developed in order to address the need for a portable, battery operated instrument to rapidly, and unambiguously, identify a wide variety of nuclides: most importantly, threat nuclides, but also natural, industrial and medical nuclides which might be encountered in commerce streams and at border crossings [1]. The correct identification of these latter categories is vital in order to identify the causes of alarms from gross counters

(PVT based radiation portal monitors and radiation pagers) and lower performance handheld identifiers based on NaI(Tl) or LaHalide scintillators. For this reason, ORTEC scientists embarked on the development of an instrument based on high resolution, high purity germanium (HPGe) gamma ray detectors, despite some considerable technical challenges. The resultant Detective family of handheld radioisotope identifiers (RIIDs) was built to meet the requirements of ANSI N42.34 and an IAEA publication on border monitoring [2]. The performance has been widely tested and reported [3–11]. The Detective-EX (the larger of the two instruments) is shown in Fig. 1.

As the efficacy of the Detective became more apparent, further potential opportunities for the deployment of this technology emerged and the need for a physically smaller instrument was obvious. A development project was started to reduce the size and weight with no loss of identification capabilities or reduction in the instrument's ability to withstand rough handling.

It was decided not to change the size or aspect ratio of the HPGe crystal, partly to maintain the advantage of the low energy efficiency of the large area crystals, but also to ensure compatibility of the characteristics with the existing instruments. The Detective-EX neutron detector has, by a large margin, the highest efficiency of any RIID with integrated neutron sensor, and far exceeds the ANSI requirements, so it was decided to reduce the size of the neutron detector in the new instrument, but still be sensitive enough to meet the required standards.

FIG. 1. Detective-EX and prototype MicroDetective.

A more rugged case with splash or rain resistance was considered desirable. The prototype of the new design is shown in Fig. 1 alongside the Detective-EX. The reduction in size is apparent. At this stage, the instrument controller (a PDA is used in the Detective-EX) was protected by the use of a waterproofed enclosure which had the disadvantage of unnecessary size.

The commercial version of the new instrument (available early in 2008) incorporates several of the hardware features developed under the HPRDS project. The product is named 'MicroDetective' and shown in Fig. 2. The major components are: a Stirling cooler with 50 000 h design lifetime, a 50 mm × 30 mm crystal in a vacuum hardened cryostat and Li-ion batteries for >3.5 h of operation. Hundreds of Detectives in continuous operation worldwide have proven the reliability of the Stirling cooler technology in these applications. As in the Detective, the MicroDetective is designed as a 'run forever' instrument. The cooler's long operational lifetime means it can be powered and cold all the time, ready to be used instantly. The hardened cryostat means the unit can be cooled from any temperature without damage to the crystal, eliminating the 'short cycle' problem inherent in the temperature cycling of conventional HPGe cryostat designs.

As with the Detective, the large surface area HPGe crystal gives the highest efficiency in the energy region most effective for special nuclear materials (SNM). The long life batteries give an ample, useful operating time away from mains power and the unit can be powered and charged from any

FIG. 2. Final MicroDetective.

12 V source. Unlike the previous Detective instruments, the battery charger circuit is internal. For recharge, the instrument simply requires a DC input. The DSP MCA gives good resolution and peak shape. The spectral data can be stored internally and transferred to a PC for archive and transmission to remote analysis facilities using the high speed USB connection. The USB connection can also be used to control the MCB from any ORTEC CONNECTIONS™ program, allowing the MicroDetective to be used as a data logging device.

The MicroDetective employs a customized built-in processor and display rather than a COTS PDA as the instrument controller and human interface. This approach further reduces the weight slightly, and makes the instrument less bulky. It eliminates the short life cycle associated with COTS PDAs and offers a large number of configurable options such as wireless 802.11 communications, GPS, and slots for data storage such as CF and SD. The instrument display is a full VGA colour readable in sunlight and has greater clarity than the PDA display. Like other models, the spectroscopy is performed by an ORTEC designed DSP based MCA with enhanced digital signal processing [12], and the latest version of the Detective analysis software for rapid and accurate identification. The MicroDetective user interface is essentially the same as the 'classic' user interface of the Detective-EX.

At 6.8 kg, the MicroDetective is 40% lighter than ORTEC Detective-EX, and 55% lighter than the only other commercial isotope identifier based on HPGe at the time of writing. The MicroDetective will be commercially available in January 2008, extending the existing model range.

2. HUMAN PORTABLE RADIATION DETECTION SYSTEMS (HPRDS)

The HPRDS programme was announced in October 2006 by the US Department of Homeland Security. AMETEK AMT (ORTEC) was one of the contract recipients.

The MicroDetective first prototype was used as the ORTEC development platform for HPRDS. The HPRDS programme is still ongoing. A user interface standard has been developed by DNDO in conjunction with a team of instrument manufacturers and users from various US Government organizations. This interface combines the functionality of search and identify into a single mode of operation.

Algorithms used in the ORTEC HPRDS are designed to meet more stringent ANSI N42.38 sensitivity requirements for advanced spectroscopy portal monitors rather than significantly less sensitive requirements of ANSI

N42.34 for handheld radiation identifiers. One handed operation is achieved by using push buttons located on the handle of the instrument. Radiation alarms are annunciated by sound, coloured classification specific indicator lights on the instrument front panel, and vibrations in the handle. Figure 3 shows a detail of the HPRDS version indicator lights and in-handle buttons. Figure 4 gives an example of an HPRDS display. When the HPRDS programme is completed, the MicroDetective will be further developed to embody the best, if not all, of the HPRDS developed features.

FIG. 3. HPRDS prototype detail.

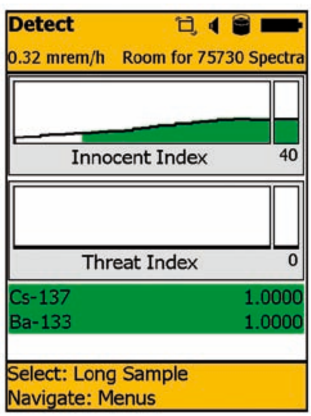

FIG. 4. HPRDS display example.

3. PORTAL MONITORING DEVELOPMENTS

The problem of innocent alarms at ports and border crossings is well known and has been widely reported and discussed [13, 14]. The DNDO's Advanced Spectroscopy Portal Monitor programme is intended to demonstrate and sponsor the development of spectroscopic portal monitors capable of automatically solving the majority of these alarms without requiring manual inspection. Manual inspection takes an average of 15 min for a truck at a border crossing, greatly impeding the flow of commerce. Independent of the ASP programme, which has recently suffered from programmatic delays, ORTEC has continued the development of solutions for spectroscopic portal monitoring based on the now undisputed performance advantages of HPGe as evidenced in the Detective.

There are three 'components' within this development:

— An all-in-one HPGe modular hardware device known as an Interchangeable Detector Module or IDM;
— A computer performance model which can be used to predict the identification performance (minimum identifiable activity or MIA) of portal monitors employing different numbers of IDMs;
— Modular portal monitoring software.

4. THE INTERCHANGEABLE DETECTOR MODULE

The Interchangeable Detector Module (IDM) [15, 16] (Fig. 5) is a natural extension of the Detective technology to other application areas. While the

FIG. 5. Interchangeable Detector Module (IDM).

Detective was designed for portability and hence tradeoffs between detector size, cooler power and cooldown time were made, the IDM extends the core technologies to applications where high efficiency, lower cost and shorter cooldown times are needed while battery operation is not.

The IDM is a completely integrated, autonomous spectrometer comprising:

— Large Area HPGe crystal in vacuum hardened cryostat;
— High capacity Stirling cooler;
— High performance Digital MCA;
— Control electronics.

The majority of gamma ray emissions from SNM are in the 100–600 keV range, implying that the detection efficiency for SNM will depend mainly on the surface area of the detector. The HPGe detector crystal in the IDM is 85 mm in diameter and 30 mm deep (among the largest standard detector sizes for Ge crystals). This aspect ratio was chosen specifically based on the results of modelling performance in multi-IDM portal monitoring applications. It provides an excellent compromise for a wide variety of portal configurations.

The IDM incorporates a suite of unique features to enable it to get maximum performance in the applications where searching for radionuclides of interest in moving containers is needed. It may be used as a 'building block' component for the simplified construction of portal monitors for pedestrians, packages, vehicles, cargo containers and rail freight cars, as well as of vehicle and airborne mobile search systems.

IDM summary features are:

— Large area 85 mm × 30 mm HPGe crystal;
— High reliability Stirling cooler cools rapidly (<4 h) to operating temperature;
— Hardened cryostat designed for long operational life;
— Can be temperature cycled at any time, even from partial warm up;
— High performance, digitally stable signal processing;
— 'Hot swap' of IDM modules while in operational state — reduced downtime;
— Continuous data collection, no dead spots, using list mode.

4.1. Applications

The IDM has been designed as a flexible modular component for spectroscopic portal monitors. It may be added to existing portal monitoring installations to improve their ability to discriminate against both false negative and false positives such as NORM alarms. The modularity of the IDM makes it easy to tailor the solution to match the CONOPS (concept of operations) of the facility. If slow scanning is permissible, smaller numbers of IDMs can be used. Figure 6 shows one side of a two sided hybrid vehicle portal incorporating eight IDMs, PVT and three He detectors. Figure 7 shows the lower panel exposed with the two IDMs in situ.

FIG. 6. One side of hybrid vehicle portal.

FIG. 7. Lower panel showing two installed IDMs (courtesy Nucsafe LLC).

5. COMPUTER PERFORMANCE MODEL

A computer model [16] has been developed at ORTEC to predict portal performance in real conditions for different portal configurations populated by different numbers of IDMs. The model uses empirically determined efficiency and backgrounds to predict the results for different IDM placements and shielding conditions.

The model requires the following inputs:

(a) Fixed:
- HPGe Detector efficiency versus energy, distance and angle;
- HPGe energy resolution versus energy;
- Collimator field of view.

(b) Variable:
- — Background spectrum seen by detector;
- — Source type (nuclide);
- — Source distance from detector;
- — Source speed through detection zone;
- — Number of detectors used;
- — Vertical position of the detectors;
- — One or two sided configuration;
- — Desired detection probability;
- — Desired false alarm probability.

Any analysis technique depends on the thresholds for false positives and false negatives. These are related to the minimum detectable activity (MDA) or the minimum identifiable activity (MIA). The choice of threshold setting determines the divide between false negatives from that part of the source distribution falling below threshold and false positives from that part of the blank distribution falling above threshold. Another way to look at the same information is the integrated form of the probability distribution shown in Fig. 8.

A common definition of peak quality factor Q is:

$$Q = (G - B)/\sigma$$

where G represents the gross counts in a region of the spectrum centered at the gamma ray peak energy with a width based on the FWHM, B represents the

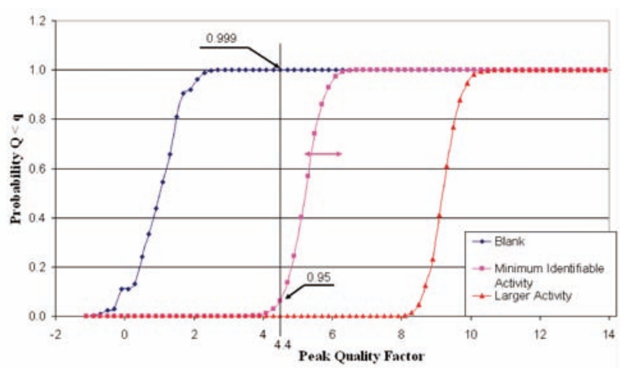

FIG. 8. Integrated detection probability distributions for blank, MIA, >MIA sources (left to right).

number of background counts in the same region and σ represents the uncertainty of value: G – B.

Note that for a high resolution detector system, the background is determined from the same spectrum as the gross count. This makes the high resolution system independent of fluctuations in the background, either from natural causes or by the cargo being measured. Low resolution systems use separately obtained backgrounds, requiring much higher threshold settings to overcome the high uncertainty in the net count.

The left most (blue) distribution in Fig. 8 shows the integrated probability distribution for a blank. With a Q threshold of 4.4, the chances of a false alarm are shown as 1 in 1000. The right most (red) distribution is for some arbitrary 'large' activity, where the probability of a false negative is seen to be effectively zero. As the activity is reduced, without moving the threshold, a position is reached where the false alarm probability is 1 in 1000 but the activity is now such that the probability of detection is 95%. The corresponding activity defines the minimum identifiable amount or MIA.

6. PEDESTRIAN PORTAL EXAMPLE

Figure 9 shows a spectrum taken with the source moving through the centre of the detection zone of a two sided pedestrian portal configured with two IDMs per side. The count time is defined at 1 s in N42.38. This spectrum was taken with 2.5 MBq ^{133}Ba, 110 kBq ^{57}Co and 728 kBq ^{60}Co sources. The MIA may be determined from the spectrum contents in the required count time. The peak quality factor (Q) [5] for 122 keV peak is about 7.1. The Q threshold for the required false positive rate depends on the local background, but is generally set to five. This gives the MIA of ^{57}Co based on the 122 keV

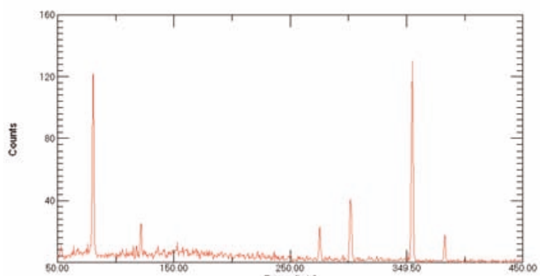

FIG. 9. 1 s pedestrian portal spectrum.

peak as less than 110 kBq for the collection time of 1 s moving at 1.2 m/s, which is lower than the ANSI N42.38 required ‘detection’ activity of 185 kBq and lower than the required ‘identification’ activity of 555 kBq by a factor of five. It should be noted at this point that the ANSI N42.38 standard allows for MDA and MIA to be different, because the possibility exists of being able to detect an increase in the gamma ray flux at a low level, but not being able to identify the nuclide without more counts.

7. VEHICLE PORTAL EXAMPLE

Figure 10 is taken from ORTEC’s own vehicle portal tests. It shows 15 g of weapons grade plutonium (WGPu) in the presence of ^{133}Ba in a 5 s transit through the portal detection zone. In this simulated masking scenario, the distinction between the WGPu target and the ^{133}Ba mask is clear, and the WGPu may be identified with high confidence; even though in the 5 s occupancy very few counts are detected, the counts are in a very narrow band of energy, making them, statistically speaking, significantly higher than background. Table 1 shows ORTEC’s modelled identification performance data with differing numbers of IDMs for vehicle portals of this type in comparison to the standard. These data are referenced to the standard ANSI test conditions as regards transit speed through the portal and represent the

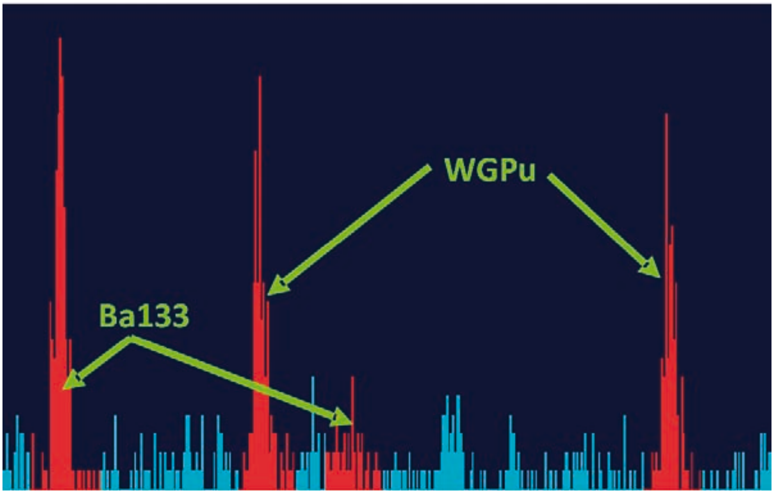

FIG. 10. ^{133}Ba/WGPu spectrum from vehicle portal.

TABLE 1. VEHICLE PORTAL PERFORMANCE FOR DIFFERENT NUMBERS OF IDMs

Source	ANSI N42.38	ANSI N42.38	8 IDM	12 IDM	24 IDM
	Required identify activity (MBq)	Required detect only activity (MBq)	Minimum identifiable activity (MBq)	Minimum identifiable activity (MBq)	Minimum identifiable activity (MBq)
^{241}Am	1.74	1.74	0.67	0.52	0.33
^{57}Co	0.56	0.19	0.15	0.11	0.07
^{133}Ba	0.33	0.11	0.26	0.19	0.11
^{137}Cs	0.59	0.59	0.26	0.19	0.11
^{60}Co	0.26	0.26	0.22	0.15	0.07

worst case performance at the portal ‘weakest point’; that is, the least sensitive part of the detection zone.

Columns 2 and 3 of the table are values taken from Table 3 of ANSI N42.38. In some cases, for example, ^{241}Am, the standard has the same requirement for detect and identify while in other cases, for example, ^{133}Ba, the ‘detect only’ requirement is more demanding than the ‘identify’ requirement. Columns 4, 5 and 6 show the predicted ‘minimum identifiable limits’ for vehicle portals based on 8, 12 and 24 IDMs, arranged symmetrically in two vertical pillars. Clearly, an eight IDM configuration easily meets the identification requirements of ANSI N42.38. In a system where eight IDMs are augmented by PVT, the gross count detection requirements can also be met.

8. MODULAR PORTAL MONITORING SOFTWARE

The overall strategy for analysis of spectra gathered with portal monitors incorporating ORTEC IDMs can be summarized as follows:

- Gather list mode, time tagged data from individual detectors;
- Apply algorithms based on the Detective ID algorithms on reconstructed time slices gathered from single detectors, adjacent detectors in combination and other larger combinations of detectors.

This strategy means that from the large amount of list mode data gathered, through a dynamic sorting process, those data which present the highest 'Q values' for the nuclides of interest can be located in the data set. Using algorithms derived from the highly successful Detective, nuclides can be reported according to the classifications 'industrial, medical, natural and nuclear'. The software can handle 1–24 IDMs in a single portal and as many as 32 lanes of traffic in a single vehicle installation. By careful analysis of the facility CONOPS, a surprisingly cost effective solution may be configured. ORTEC can also supply solutions as performance upgrades to existing installed portal monitoring systems.

9. CONCLUSION

Improvements in cryostat design, electromechanical coolers, DSP based MCAs together with experience based developments in analysis software have resulted in two seemingly different, but functionally similar, HPGe based radionuclide identification systems. One is portable and intended for threat detection in stationary situations and the other is a fixed installation intended for threat detection in moving materials such as cargo. The choice of solution depends on the definition of the problem to be solved or CONOPs.

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A STRATEGY OF DEVELOPMENT OF NEW INSTRUMENTS TO COMBAT ILLICIT TRAFFICKING
From applications towards specifications

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Abstract

The paper deals with possible variants (scenarios) of the application of two types of instruments that have become available recently on the market: personal radiation detectors (PRDs) and 'Backpacks'. While standards and requirements for PRDs exist, the application procedures have still not been elaborated. Standards for Backpacks are at the first stage of elaboration only, however, their penetration into the radiation control areas has already started. Thus, it is very important at this stage to understand and describe the field and limits of their application. The results of research evidently testify that both instruments have certain fields of application, but the first and principal step is to elaborate the procedure of the radiation control implementation when a new type of equipment is developed.

1. INTRODUCTION

In recent decades, the scope of radioactive materials control has been significantly expanded. A new application for this control has appeared: customs (border) radiation control. The peculiarities of such control required the development of new types of equipment specifically designed to operate in this environment — from fixed radiation portal monitors being installed on State borders to small sized highly sensitive search instruments. Along with the well known fixed monitors of various types and handheld search instruments, the so-called personal radiation detectors (PRDs), which are also known as pagers or pocket type instruments, have become very popular. In recent years, a new type of instrument has been elaborated: the ‘Backpack’.

Even though the PRD type instruments have been on the market for less than ten years, the interest in these units has become quite significant worldwide. The requirements and specifications that these instruments should meet are defined in several different recommendations and standards, in particular in the American Standard ANSI [1] and IAEA recommendations [2]. These instruments are very attractive to users of radiation control instruments: customs, border patrol and other special services in different countries. However, some of the scientific community have expressed concern that the capabilities of the PRDs may have been overstated and they may not be as effective as they were expected to be in the effort to detect illicit trafficking in nuclear and radioactive materials [3].

The standards and requirements for Backpacks are at the first stage of elaboration only, however, their penetration into radiation control areas has already started. Thus, it is very important at this stage to understand and describe the field and limits of their application.

2. PRD APPLICATION AND CAPABILITIES

The minimum detectable activities (mass) of sources were estimated for the scenarios of PRD application described in the following sections. For these estimations, the pre-selected value of sensitivity of PRD to gamma radiation is 1.5 cps · $\mu R^{-1} \cdot h^{-1}$ for ^{137}Cs, which corresponds to sensitivity typical of the majority of conventional PRDs. Since in their advertising materials the manufacturers do not give information on the sensitivity of PRDs to neutron radiation, it was evaluated from the requirements for these units stated in the ANSI standard and IAEA recommendations.

2.1. Scenario 1: Location — detection and location of the source which triggered the alarm of a pedestrian monitor

In the given scenario, the PRD should be used to verify the presence of a source when an alarm is triggered from the fixed monitor. If the presence of a source is verified, the PRD is further used to locate the source on the body of a pedestrian, in carry-on luggage or in checked-in baggage. Therefore, the selected distance between PRD and the possible location of the source is 10 cm and the moving speed of PRD 0.5 m/s (as in Ref. [2]).

2.2. Scenario 2: Passport control

This is the conventional name of the procedure that involves using the PRD to detect a source in those areas where the stationary monitors are not installed. In this case, the object may remain in close proximity to the PRD for a significant period of time, possibly up to several minutes. An example of this type of scenario might be when passing through passport control. The distance between the PRD and the source is 1 m and the counting time is 60 s.

2.3. Scenario 3: Police patrol

This is a conventional name of the procedure that involves using a PRD to detect a source while patrolling an area (e.g. during public events, street patrol, checking buses, trains and boats). Given a distance between the PRD and the possible location of the source of 1.5 m, the moving speed is 5 km/h (the average walking speed of a pedestrian).

Calculations showed (Table 1) that the PRD can certainly be utilized for verification of gamma alarms of fixed pedestrian monitors and for the location of a gamma source, if the distance between the PRD and a probable source is approximately 10 cm (Scenario 1: location). It may also be used in conjunction with a vehicle monitor but only in the case where it is possible to get the PRD close enough to the source that it meets the distance requirements. If the PRD is used in Scenario 2, its capabilities in general are very restricted. Practically, the PRD is comparable with a fixed (pedestrian) monitor for low energy radio-

TABLE 1. COMPARISON OF THE GAMMA AND NEUTRON SOURCES TO BE DETECTED BY A RADIATION PORTAL MONITOR (RPM) AND THAT CAN BE DETECTED BY PRD

Source	RPM		PRD		
	ANSI 42.35 [4]	IAEA [2]	Scenario 1 (location)	Scenario 2 (passport control)	Scenario 3 (police patrol)
^{137}Cs, MBq	0.6	1.0	0.09	1.1	8.4
^{60}C, MBq	0.15	—	0.05	0.6	4.5
^{133}Ba, MBq	0.85	—	0.08	1.0	6.2
^{57}Co, MBq	3.5	1.0	0.06	0.8	7.7
^{252}Cf, 10^4 n/s	2	1.2	1–2	30	50

nuclides only — simulators of special nuclear materials (SNM) — and if the time of measurement is no less than 60 s.

If the PRD is used in Scenario 3, since the source may be located at a distance of approximately 1.5 m from the PRD, the source strength that is required to trigger an alarm in the PRD is far greater than that which can be readily detected by the fixed monitor. Therefore, it would seem that we should eliminate Scenario 3 as one of the applications in which a PRD might be used. However, it is possible to expand the applications of gamma PRDs provided that their sensitivity is increased (e.g. up to 2.5–3 cps · $\mu R^{-1} \cdot h^{-1}$) [5].

At the same time, it is questionable to utilize PRDs with a neutron channel for the verification and location of neutron sources. Moreover, even when PRDs alarm and alert the user about the presence of a neutron source, its location creates difficulties, as when locating the source the PRD should be taken off the belt, or out of the pocket. As a result, the human body is no longer a reflector–moderator of neutrons and the efficiency of neutron registration goes down and the alarm signal is stopped. To restore the alarm signal, additional equipment will be required (e.g. a moderator chamber), which will enhance the sensitivity of the instrument and allow the user to accomplish the locating procedure. Therefore, the minimum intensities of sources that can be successfully detected will be significantly higher than the values given in Table 1 for Scenario 1, i.e. (1–2) × 10^4 n/s which approximately correspond to 200–300 g of weapons grade plutonium (WGPu). This brings the ability of using the PRD, even in Scenario 1 into question. As far as Scenarios 2 and 3 are concerned, the mass of the sources is so high (much higher than the critical mass) that using a PRD in these situations simply cannot be considered.

Thus, the application of a PRD as an instrument to combat illicit trafficking of nuclear and radioactive materials can only be considered when the instrument can be placed in close proximity to the radiation source.

Therefore, despite a detailed description of the requirements for PRDs and test conditions in various standards and recommendations, the main problem is the absence of application procedures. This can confuse the user and cause difficulties in the wide utilization of these units. In our opinion, this is also a cause of significant limitations of PRD usage.

3. BACKPACK APPLICATION AND CAPABILITIES

As the actual field of Backpack application is patrolling a territory and the unit is worn on the operator's back, the main purpose of our calculations is to estimate changes of signals of gamma and neutron detectors dependent on the radiation incidence angle onto a detector (0° means direct incidence; 90° —

from one side; 180° — from behind, i.e. through a human body). For these estimations, the gamma detector is based on a plastic scintillator (5 cm in diameter, 40 cm long), the neutron detector uses two ^{3}He tubes (5 cm in diameter, 30 cm long, 2.5 atmospheric pressure) and the moderator–reflector of neutrons is a polyethylene phantom imitating a human body.

It was certainly revealed (Fig. 1) that a decrease of gamma signal when gamma radiation passes through the phantom (angle is 180°) depends considerably on the energy of gamma rays. For ^{60}Co, the signal is decreased by about 25–30% compared to a signal at an incidence angle of 0°; for ^{137}Cs, this decrease is about 40%; however, for ^{133}Ba and ^{57}Co, this decrease is as high as 2.5–3 times. As a result, the minimum detectable activity of these sources increases. This is especially important for low energies which are a characteristic feature of SNM.

The signal decrease when neutrons (^{252}Cf source) pass through the phantom (angle is 180°) can be as high as two orders of magnitude (Fig. 2). Therefore, the minimum detectable mass of neutron sources is strongly dependent on the relative position of the source and detector. It certainly has to be taken into account when application procedures for this instrument are elaborated.

4. CONCLUSIONS

The results of research evidently testify that the first and principal step is to develop the procedure of the radiation control implementation when a new

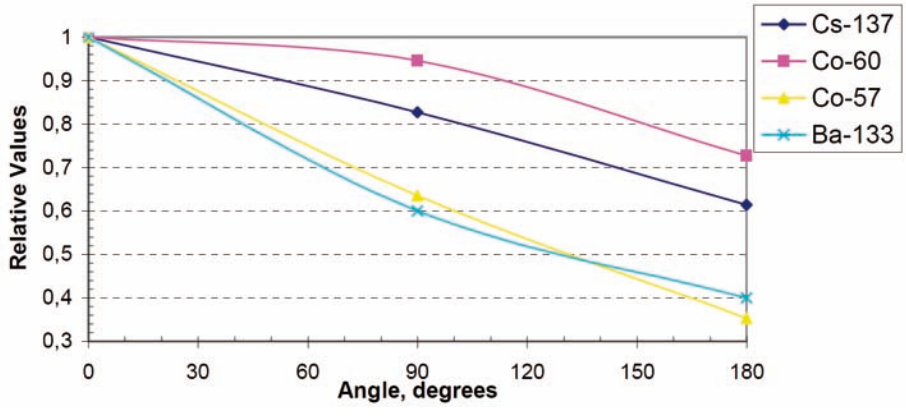

FIG. 1. Angular dependence of Backpack gamma signal for different nuclides.

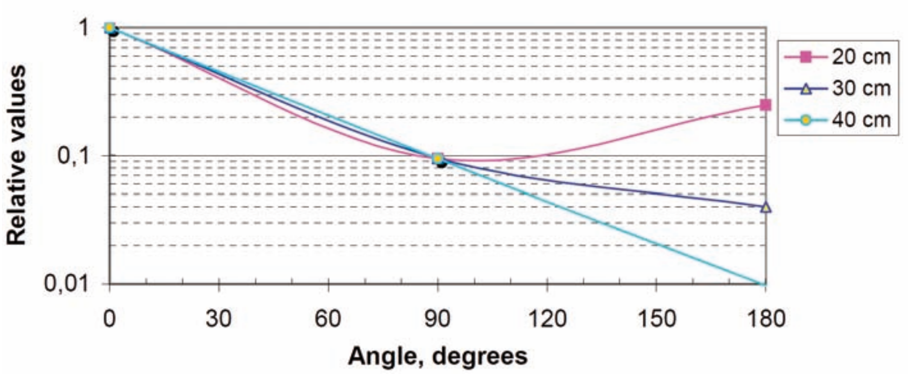

FIG. 2. Angular dependence of Backpack neutron signal at different phantom thickness.

type of equipment is developed. So, the main requirements for the equipment specifications can only be formulated if it is clear where instruments will be used (or installed), under which conditions they will be used, which tasks should be resolved using them, which sources can be detected, etc. The next step is the elaboration of standards for these instruments. It is also important that test conditions be as similar as possible to actual conditions of usage of the instruments. It is obvious that the procedures of radiation control may be different in various countries. However, some common international principles can and should be elaborated, at least as recommendations.

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INSTALLATION OF RADIATION DETECTION PORTALS AT THE NORWEGIAN BORDER CROSSING STATION AT STORSKOG

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1. INTRODUCTION

With the recent changes in the international security environment, awareness has been heightened about the possibility of increased risk of illicit trafficking of both fissile and non-fissile radioactive material to the West, including across the Norwegian–Russian border. Hence, when an initiative was started to improve the Norwegian emergency preparedness with respect to acts of terrorism subsequent to the attack on the World Trade Center in 2001, this included emphasis on the possibility of malicious use or illicit trafficking of radioactive material as well. The newly installed radiation detection portals at Storskog are a result of this initiative.

The station at Storskog is the only border crossing station on the Norwegian–Russian border; it is also the only Norwegian border crossing station on the outer border of the European Union–European Economic Area. The station is situated 7 km east of Kirkenes and is attended by the police, the Norwegian Customs and Excise, and representatives from the Norwegian Border Commissioner. The installed portals are owned and operated by the Norwegian Customs and Excise.

The radiation detection monitoring system was considered operational from early 2004, following a set of independent acceptance tests by both the contractor and the Norwegian Radiation Protection Authority (NRPA).

2. THE MONITORING SYSTEM

The proposal for improvement of the national Norwegian border control regarding radioactive material was considered by the Norwegian Parliament in June 2002, and approximately €375 000 was allocated to the improvement. It was decided to use these funds for a high quality system at the Storskog border crossing station. The system was expected to meet a set of requirements, including IAEA recommendations as described in Ref. [1]. Furthermore, for practical reasons, it was decided that the monitoring system should include in total three radiation detection portals, one for each of the customs lines. These portals monitor all traffic arriving in Norway at the station.

The installed portals at Storskog are of an 'exploranium' type, with two detection modules in each portal. The detection modules are capable of detecting both gamma and neutron emissions. The customs personnel are able to continually monitor the nature and level of radiation from their control room. If the radiation levels exceed a set limit, the system alerts the customs personnel through both audible and visual alarms, and displays the approximate radiation level and location of the radiation source within the vehicle.

3. NRPA INVOLVEMENT

NRPA has worked in close collaboration with both the police and the Norwegian Customs and Excise during the process of specifying the requirements for the radiation detection system, selecting it and installing the detection portals. NRPA has arranged several training courses for the local customs personnel and has prepared a related manual [2], providing background information and describing proper actions to be taken upon discovery or suspicion of radioactive material.

Furthermore, the NRPA emergency preparedness unit at Svanhovd is located near the Storskog border crossing station, and serves as a second line service for the station. The unit has regular tests of the equipment, and provides the station with both scientific expertise and in situ assistance when needed. The unit is continually informed of the performance of the system and of any alarms, and is at any time able to electronically connect to the system in order to assess and comment on any particular measurement.

4. EXPERIENCE WITH THE MONITORING SYSTEM

Since the radiation detection portals were initially used in November 2003, the system has produced alarms on several occasions. Most of these alarms have been ‘false’ alarms, in the sense that no actual radioactive material was present. This type of alarm occurs during large variations in the background radiation level, commonly due to adaptation by the system to different shielding attributes in vehicles. On occasion, the system has produced ‘innocent’ alarms, where legitimate transportation of non-fissile material with coincidentally elevated radiation levels was detected by the monitoring system. So far, these alarms have exclusively been caused by the transport of Russian reindeer meat contaminated with ^{137}Cs; however, the transport of scrap metal, wood, rock, soil or ore, etc. could also cause similar alarms.

Until now, there have not been any ‘real’ alarms, where radioactive material of concern has necessitated intervention by the authorities.

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IAEA-CN-154/071P

AN EVALUATION OF PAKISTAN'S MEASURES TO COMBAT ILLICIT TRAFFICKING

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Abstract

Combating illicit trafficking is a major concern worldwide. The measures taken by Pakistan for combating illicit trafficking are evaluated in the paper.

1. DESCRIPTION OF PAKISTAN'S MEASURES

1.1. Implementation of international instruments

Pakistan is party to the Convention on the Physical Protection of Nuclear Material (CPPNM) and is trying to follow the norms in its true spirit.

Pakistan is effectively implementing the Code of Conduct on the Safety and Security of Radioactive Sources and subsequent guidance for effective and continuous regulatory control to reduce the vulnerability of radioactive sources, and control the import and export of radioactive sources.

Interministerial discussions are in progress on Pakistan's accession to the Convention for the Suppression of Acts of Nuclear Terrorism.

Pakistan has submitted its report to the relevant United Nations Security Council committee concerned with Resolution 1540.

1.2. Supporting international initiatives and efforts

Pakistan has recently joined the Global Initiative to Combat Nuclear Terrorism. Under this initiative, Pakistan will build the capacity to combat the global threat of nuclear terrorism and to detect and suppress illicit trafficking activities involving such materials, especially measures to prevent their acquisition and use by terrorists.

Pakistan is benefiting through the US Container Security Initiative and is also discussing the adoption of US Megaports Initiatives.

1.3. Import/export control mechanism

The Pakistan Nuclear Regulatory Authority (PNRA) controls the import and export of nuclear substances/radioactive material and equipment used for production, use or application of nuclear energy for the generation of electricity or any other uses of these in the country through the instruments of No Objection Certificate (NOC) and License.

An export control bill was introduced in 2004 which provides controls on export, re-export, trans-shipments, transit of goods, technologies, materials and equipment related to nuclear and biological weapons, and their means of delivery.

PNRA is assisting the implementation of the Export Control Act 2004 in the nuclear field. The Strategic Export Control Division (SECDIV) implements the Export Control Act 2004. PNRA is a member of the oversight board which is the governing body of SECDIV.

1.4. National capabilities and efforts

The national infrastructure and competencies are being improved under the National Nuclear Security Action Plan (NSAP) [1] being implemented through PNRA.

1.4.1. PNRA

The nuclear regulatory infrastructure has been in place in Pakistan since 1965. The Nuclear Safety and Licensing Division was established at the Pakistan Atomic Energy Commission (PAEC) until it was upgraded to the Directorate of Nuclear Safety and Radiation Protection (DNSRP) through an ordinance in 1984. Pakistan signed the Convention on Nuclear Safety in 1994. Under its obligations, a Nuclear Regulatory Board (PNRB) was established in 1996 until the establishment of PNRA in 2001.

PNRA is a competent and independent body for the regulation of nuclear safety, radiation protection, transport and waste safety in Pakistan, and has been empowered to determine the civil liability for damage resulting from any nuclear incident.

The Ministry of Commerce issues the national trade policy (including import and export) on an annual basis. The coordination related to import/export control between commerce authorities and the regulatory body has been established and has been addressed in the trade policy since the 1970s. PNRA, since its establishment in 2001, has developed coordination with customs authorities for import/export control.

1.4.2. NSAP

PNRA's nuclear security action plan (2006–2011) is based on the working definition of nuclear security. The objective of NSAP is the development of a national, sustainable system in nuclear security with the established response and recovery capabilities, integrated with national laws, regulations and procedures. NSAP includes the following activities:

— Management of radioactive sources in Categories 1, 2 and 3, and evaluation of vulnerable facilities and supporting their security efforts: The frequency of the inspections is to be increased for these sources and a follow-up mechanism would ensure that the inspections' findings are implemented promptly. It has been proposed that PNRA regional directorates be augmented with additional officers, technical staff, equipment and three inspectorates;
— Establishment of the PNRA Nuclear Safety/Security Training Centre: PNRA, being the focal point, will provide the training in the field of nuclear safety and security with the approach of prevention, detection of and response to as the first, second and third lines of defence, respectively. The proposed training centre will be equipped with laboratories having state of the art equipment for detection, identification and verification related to nuclear incident and radiological emergencies;
— National Nuclear Security Emergency Coordination Centre (NuSECC): NuSECC will be established for coordination with governmental agencies such as customs, border forces, local governments and PNRA regional directorates and inspectorates in handling a nuclear security emergency at national level. NuSECC will be staffed around the clock. Mobile monitoring laboratories, one each at the regional directorate/inspectorate will also be established;
— Locating and securing orphan radioactive sources: Orphan sources include a source which poses sufficient radiological hazard to warrant regulatory control, but which is not under regulatory control because it has never been so, or because it has been abandoned, lost, misplaced, stolen or otherwise transferred without proper authorization. These sources need to be located, secured and disposed of to reduce the risk of their being used to perpetrate malicious acts or finding their way to scrap foundries. The strategy in this regard involves launching a public campaign through electronic and print media seeking information on orphan sources, locating such sources through non-physical and physical searches, recovering and securing the sources, and finally disposing of

these at disposal facilities to reduce the risk of their being used to perpetrate malicious acts or finding their way to scrap foundries;

— Provision of detection equipment at strategic points: Detection equipment at strategic points is needed for the better control of illicit trafficking of radioactive material/sources and prompt response to radiological emergencies. It has been proposed to provide radiation detection equipment to personnel working at the entry/exit points to monitor the ingress and egress of nuclear/radioactive materials.

The IAEA is also supporting PNRA in its activities related to NSAP.

PNRA is in the process of establishing regional inspectorates in addition to already existing regional directorates to ensure prompt support to the first responders in case of an emergency including unauthorized acts involving illicit trafficking. Mobile emergency support teams (MESTs) fully equipped with mobile emergency laboratories will be available at these regional centres to provide support to the first responders if and when required.

PNRA has initiated discussions with the IAEA for support in establishing laboratories at a nuclear security training centre, including the radiation detection equipment laboratory, testing and certification laboratory, maintenance laboratory and emergency response equipment laboratory.

A public awareness campaign regarding stolen, abandoned, lost, orphan and unregulated radioactive sources and material was completed in June and July 2007. The Nuclear Security Emergency Coordination Centre is functioning in Islamabad with a toll free number and is being staffed around the clock.

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USING RADIATION MONITORS TO PREVENT ILLICIT NUCLEAR TRAFFICKING
Experience of Uzbekistan

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Abstract

According to the programme of radiation monitoring in Uzbekistan to prevent illicit nuclear trafficking, main customs border checkpoints were equipped with radiation portal monitors. In total, 30 checkpoints (19 vehicle, 10 railway and Tashkent international airport) were equipped with 175 monitors, produced by the Russian company Aspect. Special radiation monitors were elaborated, manufactured and installed in the Institute of Nuclear Physics of the Uzbekistan Academy of Sciences (main gates, research reactor and laboratories building). The paper covers these works and other activities on preventing nuclear smuggling.

1. THE COMMON SITUATION

Uzbekistan is located on the crossroads between the north and south, and the west and east. Formerly, the big part of the Great Silk Road passed through Uzbekistan (Fig. 1). In times of an increasing threat of nuclear terrorism, when extremist organizations are threatening humankind with terrorist attacks, including the use of a 'dirty bomb', the problem of stopping illicit trafficking of fissile and radioactive materials is becoming a worldwide one. Presently, vehicles from the north (Europe, the Russian Federation, Kazakhstan) having Transport International Routing (TIR) are moving to the south and south-east, for example, to Iran, Afghanistan and other countries.

All these vehicles are possibly involved in nuclear smuggling because they are allowed to pass through border crossing points without inspection. The cargo can only be inspected if there is sufficient suspicion that it does not correspond to that indicated in the cargo manifest declared by the cargo

FIG. 1. Possible smuggling routes in Central Asia.

sender. It is clear that radiation control could exclude completely, or to a great extent decrease, the possibility of illicit trafficking of fissile and radioactive materials through the territory of Uzbekistan. Earlier, customs and border guard officers at the main entry points were equipped with radiation pagers which were attached to their belts. However, the effectiveness of these devices was not sufficient because of the high noise level from passing vehicles which was interfering with the pager signal. Besides, they have low detection sensitivity, and the possibility of monitoring railway trains and pedestrians was very problematic. In our mind, solving the problem was made possible by installing stationary portal radiation monitors at the main customs border crossings or entry points. Their high sensitivity permits them to detect signals exceeding background level by several per cent in moving objects by recording these signals in the computer and the object itself (vehicle, train or pedestrian) on a videocamera. The considerable dimensions of gamma radiation detectors (several thousand square centimetres) allows the monitors to have a high sensitivity, and that is why various companies in the world manufacture them. Comparative evaluation of radiation monitors produced by world manufacturers shows that their parameters are more or less equal with varying service levels and costs. In our case, we used the most appropriate radiation monitors, in our opinion: 'Yantar', produced by the Russian company Aspect. Yantar stationary systems for the detection of fissile and radioactive materials are designed for detecting radioactive and nuclear materials during continuous automatic monitoring of vehicles, trains, pedestrians and luggage at various checkpoints, nuclear power plants and nuclear cycle facilities. The basic set consists of pillars with detectors, electronic units and a control panel (a personal computer can be used instead). A video monitoring system, network devices, additional alarm devices, traffic lights and drop bars are optional. The specifications of the system are as follows: false alarm rate — no more than 1/1000; operation — continuous, automatic; uninterrupted operation after disconnection of 220 V power supply — no less than 10 h; service life — 12 a; bus with interface RS-485; protocol — MODBUS. The features of the system are as follows: light and audible alarm indication; automatic adaptation to the varying natural background; archival storage of the alarm event data: date, time, detector count rate, type of channel (gamma or neutron); an optional video monitoring system provides a record of an alarm causing object; gamma detector based on organic plastic scintillators; neutron detector based on proportional ^{3}He counters; operating temperature from –50 to +50°C; compliance with EMC requirements for nuclear instruments; lightning protection of power and signal lines; possible integration of up to 16 systems of different types into a single information network without extra hardware and software; possible remote access. This company produces radiation portal monitors for radiation level control of vehicles. These monitors are installed at one or two lanes of the road, the same is valid for railway cars and pedestrians. There are special radiation monitors for controlling the transport of metal scrap, cargo in warehouses, etc. One can find the information on the Aspect web site (www.aspect.dubna.ru). Normally, the vehicle customs border crossing was equipped with monitors for both lanes of the road at entry and exit points. Besides, at pedestrian passages, radiation monitors for pedestrian control were installed. The passage of vehicles and pedestrians was under videocamera surveillance. All information about radiation levels and video was transmitted to a server installed in the room of the customs officer on duty. In the case of the detection of a signal exceeding background level, a light and sound alarm was triggered and the data on radiation levels along the vehicle (railway car) length both on gamma radiation and neutrons were recorded on the server memory. It helps to reveal the location of the shipment with maximal radioactivity. In the case of pedestrians' monitoring, the pedestrian was recorded (including the face). For a railway station case, the number of the car was also recorded. The programme of radiation monitoring in Uzbekistan to prevent illicit nuclear trafficking is supposed to equip the main customs border checkpoints with such monitors. For monitoring pedestrians, radiation monitors Yantar-1P, Yantar-2P and Yantar-U were used. For radiation monitoring of vehicles, radiation monitors Yantar-1A and Yantar-2A were installed. Railway checkpoints were equipped with Yantar-1ZH and Yantar-2ZH monitors. All these radiation portal monitors have gamma and neutron detection channels. To date, 30 checkpoints have been equipped including 19 vehicle (red square in Fig. 2, 118 monitors) and 10 railway (black colour in Fig. 2, 40 monitors) checkpoints and Tashkent international airport (blue colour in Fig. 2, 12 monitors). The higher military–customs institute was equipped with two monitors. The Institute of Nuclear Physics was equipped with three monitors. The total number of monitors is 175.

The Institute of Nuclear Physics of the Uzbekistan Academy of Sciences provides stable operation of these radiation monitors, technical assistance and consultancy in case of alarm signals and regular technical maintenance. Besides, 'KRIK' radiation monitors [1] were elaborated and manufactured at the institute. The operational principle of these monitors differs from the other ones. In our opinion, if other countries follow Uzbekistan's lead, the threat of nuclear smuggling will be essentially reduced. The experience of operation of radiation monitors has shown that the majority of alarms were innocent ones

FIG. 2. Disposition of radiation portal monitors at the main customs checkpoints of Uzbekistan.

caused by NORM radionuclides, mainly ^{40}K in various industrial products, such as building materials, ceramics and mineral fertilizers. In some cases, contaminated materials were detected. At Yallama customs checkpoint, an alarm was caused by a truck with a molybdenum oxide shipment.

The analysis of the shipment had revealed that part of it was contaminated with ^{235}U, ^{238}U, ^{240}Pu and some uranium fission products (Figs 3, 4). The origin of the shipment was Kazakhstan. Another case of detection of contaminated materials happened at the Alat customs checkpoint. The alarm was caused by a truck with a zinc powder shipment. Detailed analysis showed that the main source of contamination was the radioisotope ^{137}Cs.

2. RADIATION DETECTORS ELABORATED IN INP AS RU

The working principles of modern monitors is based on a comparison between measurements of natural background with and without an object. A

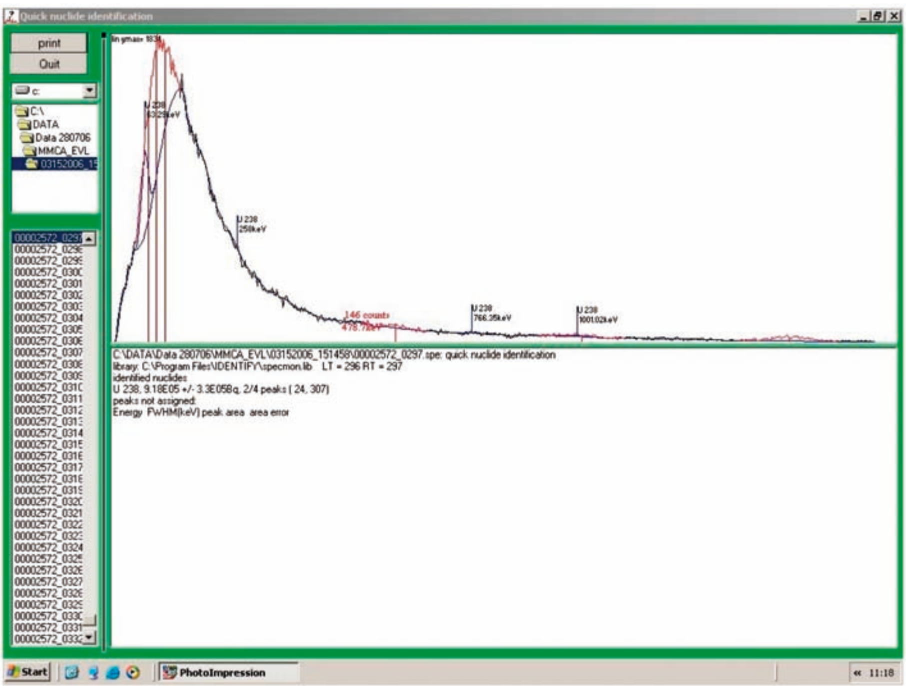

FIG. 3. Gamma spectrum of shipment sample measured with MCA-16 and NaI(Tl).

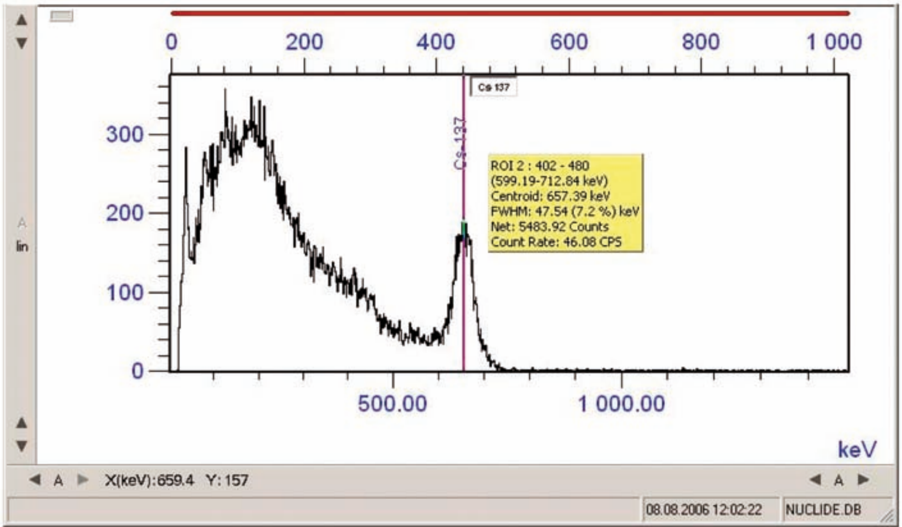

FIG. 4. Gamma spectrum of shipment sample measured by IdentiFINDER.

switch to background measurements is produced by an object sensor. At given values of background excess over the background value measured without an object, an alarm signal will be set off. Monitors designed this way have a few weak spots leading to false alarms: object sensor (performance of an object sensor depends on season, traffic intensity and a number of other factors); dependence on natural background (the background continuously changes for technogenic reasons, cosmic radiation and others). We have devised a method independent of such disadvantages. In our case, comparison is made between the number of counts from two detectors placed at some small distance from each other along the radioactivity traffic direction line and separated by lead protection (Fig. 5). The working parameter in this case is the difference between count rates from these two detectors. Closely located detectors allow one to exclude background deviations, including the cosmic component, and ideally this difference equals zero or some magnitude close to a constant value. The difference between count rates does not change or changes insignificantly at an object pace not containing radioactivity. In the presence of an object containing radioactivity, the count rate at the first detector increases, and the difference also grows, as the second detector is protected by lead. At further passage of an object, two difference peaks of different polarity are observed (Fig. 5).

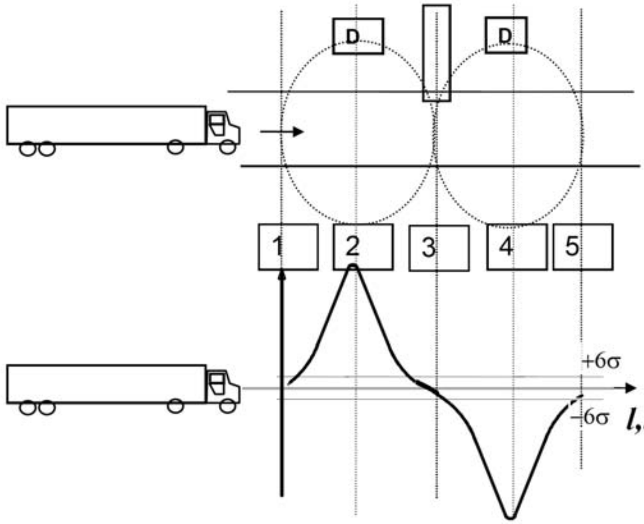

FIG. 5. The difference counting method of radioactivity detection in moving objects.

The logical circuit responds to the appearance of these two peaks as well as their values, and at a peak of different polarity exceeding a set value an alarm signal is set off. During testing of the proposed method, the radiation source ^{137}Cs with an activity of 80 kBq from reference materials was moved along the detectors' position line at a natural background of 577 counts/s. Consequently, each detector measured radiation level every 10 cm with a time step of 1 s, and determined their difference. The two peaks with different polarity are precisely determined. The background was artificially increased from 960 counts/s up to 5775 counts/s, that is, more than ten times, but still the difference peak was there. The same ^{137}Cs source was transported along the detectors' position line for a period of three weeks continuously. During this period, not more than two false alarms per week were observed. This is a significantly better result than the ITRAP requirements concerning monitors, which is very important for high traffic. Thus, if 25 false alarms are acceptable for 10 000 passages, then our testing is carried out for 5 s, that is, in a week's time one will have 86 400 passages and, therefore, one false alarm for 40 000 passages. Thus, these tests demonstrated that false alarms do not appear at ten times background changes, and the system confidently detects transported radioactivity of approximately 80 kBq. In real conditions, such tests were conducted by means of modifications of KRIK monitors with plastic scintillators designed in our laboratory. An alarm signal from the detectors is transferred to a counter placed in the computer. The main operations on analysis of signals from detectors and decision making upon an alarm is performed by an industrial computer by means of specially designed software.

At the Institute of Nuclear Physics, it was suggested to detect nuclear fissile materials by use of instantaneous gamma quanta, which accompany every spontaneous or induced decay of a nucleus. Since the intensity of gamma radiation following spontaneous neutron decay is much lower than the gamma radiation accompanying an alpha decay, the former gamma radiation has not been used for passive analysis. We have examined the use of the high multiplicity of this gamma radiation for coincidence detection. Weapons grade plutonium ^{239}Pu [2] contains approximately 6% ^{240}Pu, therefore, the spontaneous decay activity of 10 g of ^{239}Pu is ≈280 Bq. Here, neutron yield by spontaneous decay is ≈600 n/s, neutron yield in (α, n)-reaction is ≈380 n/s. A coincidence of instantaneous gamma quanta was detected by a system of two organic scintillators. The area of every scintillator was 1200 cm^2. Neutrons were detected by a set of ^{3}He counters with a total area of 1200 cm^2. A level of background coincidences can be determined by natural cascade processes. During studies, a square law dependence of background coincidences of the distance as well as of the width of lead protection between detectors was found. The experimental results obtained in our laboratory allowed us to evaluate the level of background for a system with a number of coincidences of 0.35/s. That is, a calculated signal of instantaneous gamma quanta coincidences from 10 g of ^{239}Pu is comparable to a background level as well as a calculated signal by neutrons. Based on the theoretical results of our study, a conclusion was made that it is possible to detect fissile nuclear materials implementing the proposed method. The radiation monitor using the proposed method was developed. Functionally, the monitor consists of two/four detectors (for pedestrian/vehicular monitors, respectively) based on organic scintillators with an area of 1200 cm^2 each, coincidence circuit, counter module and industrial computer with software. Advantages of this system are the following: detection of fissile nuclear materials in an object; use of only one type of gamma ray detectors; low price of radiation monitor. Disadvantages of this system are: low sensitivity at detection of alpha–neutron sources; no isotope identification due to the incapability of differentiation of gamma ray energy. However, alpha–neutron sources can be detected by background excess based on sufficiently effective detection of gamma quanta and neutrons by a 10 cm thick scintillator. Based on the obtained results, we conclude that it is possible to implement this method for the detection of fissile nuclear materials.

3. CONCLUSION

The programme of radiation monitoring in Uzbekistan to prevent illicit nuclear trafficking by equipping the main customs border checkpoints with such monitors has been implemented. To date, 30 checkpoints have been equipped, including 19 vehicle (118 monitors) and 10 railway (40 monitors) checkpoints and Tashkent international airport (12 monitors). The higher military–customs institute was equipped with two monitors. The Institute of Nuclear Physics was equipped with three monitors. The total number of monitors is 175. The Institute of Nuclear Physics of the Uzbekistan Academy of Sciences provides stable operation of these radiation monitors, technical assistance and consultancy in case of alarm signals and regular technical maintenance. The difference counting method with two scintillation detectors for the detection of radioactive materials in moving objects is proposed. For detection of fissile materials, the registration of fission acts by gamma–gamma coincidence detection of prompt gamma quanta from nuclear fission is proposed.

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SESSION 8

PANEL 2

THE WAY FORWARD

Chairperson: **A. Nilsson** (IAEA)
Members: **B. Perrin** (Canada)
M. Hoffman (Germany)
A.J. Al Khatibeh (Qatar) (replaced by B. Weiss)
N. Evans (Canada)
L. van Dassen (Sweden) (replaced by C. Price)
C. Stoiber (United States of America)
P. Thompson (United Kingdom)
M. Mayorov (IAEA)

Scientific Secretary: **B.H. Weiss** (IAEA)

RAPPORTEURS SUMMARIES

PANEL 2

THE WAY FORWARD

M. KHURSHID KHAN (Pakistan): This conference has brought out many issues that need to be addressed by individual States. Many of us need to improve our domestic legislative measures, including those for installing more technical features that would enable us to improve our export and import control. Developing countries still urgently need support from technologically more developed countries to help us curb the illicit trafficking of radiological and related material. A joint effort and close cooperation is vital. I assure the international community that Pakistan's wholehearted support in this regard is ongoing. We are working very closely with our friends, including the USA, the United Kingdom, Japan, France, Germany — individually and as part of the European Union — the Russian Federation, the IAEA and the Organisation for the Prohibition of Chemical Weapons (OPCW).

M. CAMPBELL (United Kingdom): C. Stoiber noted that sometimes customs officers were moving away from duties relating to portal monitors. It is important to bear in mind that, in emerging economies, customs officers receive a substantial proportion of their income from seizure rewards. Those rewards are based on commercial seizures and the value of the goods, so they will give that work priority. Perhaps we need to look at the economics of reward mechanisms and compensation for officers who are doing this important work — where we hope they do not make seizures.

C. STOIBER (United States of America): In my experience, this is a relevant observation. Customs officials should have the proper incentives to do the work expected of them.

W. GELLETLY (United Kingdom): Speaking as an outsider to the topic, I wonder if you have fully engaged the academic world in helping support what you are trying to do. There were very few speakers from academia although there were a few papers which obviously involved academics. I feel there could be more support for this work from the academic world.

C. STOIBER (United States of America): Specifically with regard to legal development, the comment is appropriate because in the area of nuclear law and the legal aspects concerning illicit trafficking, not many countries have established dedicated academic programmes. I participate every year in the International School of Nuclear Law at the University of Montpellier. Also, the Law School at Aberdeen has a programme in this area. I find — particularly in the legal area — engaging academics in this field could be of great benefit. I am sure that is true in other areas too.

A. NILSSON (IAEA): The comment is relevant but it has to be seen together with some practical aspects. How can this be best done? One way of engaging academia more is through the education system. The IAEA has started by mobilizing resources from a few universities to shape modules in the educational programmes that deal with nuclear security related subjects. Of general interest are the relevant legal, science and technology related questions, all of which must be part of the background of young people who plan to play a role in this field or related ones. Suggestions are always welcome on the question of how.

RAPPORTEURS SUMMARIES

Session 1: Illicit Trafficking and Nuclear Terrorism — I and II
B. Perrin, Canada

Session 2: International Instruments and their Implementation — I and II
M. Hoffmann, Germany

Session 3: International Initiatives and National Efforts to Establish Capabilities — I and II
A.J. Al Khatibeh, Qatar
Presented by B. Weiss

Session 4: Establishing Capabilities to Detect Illicit Trafficking — I and II
N. Evans, Canada

Session 5: Responses to the Detection of Criminal or Unauthorized Movement of Radioactive Material — I and II
L. van Dassen, Sweden
Presented by C. Price

Session 6: International Initiatives and National Efforts to Establish Capabilities — III and IV
C. Stoiber, United States of America

Session 7: New Technologies — I and II
P. Thompson, United Kingdom

Poster Sessions
M. Mayorov, IAEA

RAPPORTEUR'S SUMMARY

Session 1: Illicit Trafficking and Nuclear Terrorism Parts I and II

B. Perrin, Canada

During these sessions, representatives from academia, international and State level organizations presented a common theme expressing challenges, potential problems and opportunities to better understand the dynamics and motivation of the terrorist, and the linkages between nuclear trafficking and terrorism. The complexity and scale of the issues need to be carefully assessed to ensure the appropriate effort is being applied to the areas most warranted. Terrorists are learning organizations and are capitalizing on societal vulnerabilities and exploitations already established by other criminal elements. The similarities are most evident when assessing the trafficking routes and smuggling tactics.

The terrorists are operating in a global theatre. This in itself presents challenges to the law enforcement and security communities. Linguistic, cultural and political differences, divergent regulatory and legal systems, and resources constraints all complicate efforts of international cooperation and coordination.

Although there is a belief that security and law enforcement practitioners have an understanding of the threats that exist, statistical evidence suggests that the demographics of the 'actors' are not consistent with the perception or belief. This perception can lead to inaccurate assumptions regarding the motivations, tactics and target selection used by the terrorist element. The presenters, in an effort to better understand the nature of illicit nuclear trafficking, described several databases. It was also noted that the data sets differed in content and analysis due to differing data sources and degrees of validation. The broader issue may be law enforcement and security practitioners' ability to accurately predict future acts of terrorism.

We need to find the optimum point where legitimate trade is not inconvenienced while optimizing security. The challenge will be identifying the proper balance between legitimate trade and commerce, on the one hand, and legitimate security concerns regarding detection and interdiction on the other.

The public's confidence may be falsely bolstered by the fact that no significant nuclear terrorist action has occurred. This sense of security needs to be tempered to ensure that the mere absence of the act does not lure us into a state of complacency. The absence of a radiological terrorist event should not be construed as an indicator of success by the security and intelligence community. Rather, the absence of the act should be a caution that, to date, the motivators, capability and capacity of the terrorist have yet to culminate.

In conclusion, security, intelligence and law enforcement practitioners must utilize the limited resources that are available in a logical and precise manner. To best prioritize our efforts, regional, national and international cooperation and opportunities must be built upon. We must differentiate between the ‘signals and the noise’ and, as was suggested during this session, “finding a needle in a haystack is easier if the haystack is small.” Further discussion in this regard is warranted.

RECOMMENDATIONS

As the path forward will not only require a coordinated effort by international, national and regional security and intelligence disciplines, it will also require the active engagement of the private sector and technology developers. Future international activities of a similar nature should engage representatives from the private sector.

These meetings and discussions are beneficial, and support the continued battle against illicit trafficking. It is highly recommended that these activities remain a priority on an ongoing basis.

RAPPORTEUR’S SUMMARY

Session 2: International Instruments and their Implementation

M. Hoffmann, Germany

C. Stoiber, USA, presented “Model Elements for a National Legal Framework on Illicit Trafficking”. Preventing and responding to illicit trafficking is a national task and States have to implement the binding or non-binding international regulations into their national law. By analysing the international framework, one can identify some key objectives for a national legal system, for example, the prohibition of unlicensed transfers of radioactive materials.

A. Semmel, USA, spoke about the US initiatives to combat nuclear smuggling. He identified three central elements: the Global Initiative to Combat Nuclear Terrorism, the Global Partnership, and the Nuclear Smuggling Outreach Initiative. These initiatives lead to regional and worldwide cooperation in research, training, etc. for the prevention of, the detection of and the response to nuclear terrorism. Many States could benefit from participating in these initiatives. A. Semmel stressed the point that the initiatives have to be nimble to respond to the threat and that the USA is willing to listen to all partners in the projects.

S. Abousahl, European Commission, gave detailed information on the instruments of the nuclear security programme of the European Union, which has three objectives: addressing the threats, building security in the European Union’s neighbourhood and establishing an effective multilateral system on the basis of the United Nations. The programme is designed to prevent the proliferation of weapons of mass destruction through identification, detection and response. There is an emphasis on cooperation and coordination between States.

A.J. Al Khatibeh, Qatar, reported the activities of Qatar to build up capacities to counter illicit trafficking of radioactive and nuclear material. Qatar has established an effective legal system that stands in compliance with international standards and has signed an arrangement with the IAEA for assistance on their border monitoring project. In the first phase, Qatar will install 13 vehicle and four pedestrian portal monitors for radiation to monitor the ingoing traffic. In the second phase, similar equipment will be installed to monitor outgoing materials and passengers. A.J. Al Khatibeh requested secure channels for exchanging regional information on nuclear security through the IAEA to promote cooperation in the field of combating illicit trafficking in radioactive and nuclear materials. He also requested that the IAEA continue to encourage more States to join the binding and non-binding agreements for the prevention of nuclear trafficking.

S. Evans, United Kingdom, spoke about the United Kingdom Global Threat Reduction Programme, which deals especially with Russian Federation nuclear weapons, plutonium reactor shutdown and nuclear security programmes. The nuclear security programmes are of the greatest importance, because they help to reduce the material that might be illicitly trafficked. The commitment of the United Kingdom to the projects running at the present time was emphasized, although it was indicated that further cooperation with the Russian Federation was not possible. The suggestion was made that the conference delegates should think about how best to highlight successful projects to the wider community.

A. Biernacki, International Civil Aviation Organization (ICAO), reported on the aviation security challenges and actions by ICAO. She explained the binding legal system given by the ICAO for its 190 member States, ICAO Aviation Security Programme. There are 16 Aviation Security Training Centres (ASTCS) all around the world.

V. Friedrich, IAEA, focused on the current status of the implementation of the Code of Conduct on the Safety and Security of Radioactive Sources. He highlighted the enormous significance of the Code of Conduct for preventing the malicious use of radioactive sources. The Code of Conduct itself contains rules for national legislation, regulation and regulatory bodies. It is a non-binding legal instrument and States are in different phases of its implementation.

J.L. Paredes Gilismán, Cuba, presented a talk about Cuba’s commitments on security and non-proliferation. He showed the Cuban experience on the implementation of several measures as an ongoing process. Strict control over nuclear and radioactive materials resulted in cases of illicit nuclear trafficking being minimized.

D. Muleya, Zambia, spoke about the threat of illicit trafficking in an under-resourced country. Five cases were managed successfully by police and the radiation protection authority. Challenges for Zambia are the long porous borders with its neighbours and the lack of trained personnel. Zambia, therefore, plans the improvement of the national infrastructure (physical, legal and technical) and the formation of a national nuclear security commission, as well as increasing financial support.

There is an international ‘common sense’ about the legal provisions that countries should undertake on the national level to combat illicit nuclear trafficking. The objectives and key elements of this national legal framework are not controversial at all. Of course, there are differences of opinion on exactly how and to what level to implement these legal structures. These differences can be explained by differences in culture, social and economic structures, and possibilities.

Most of the contributors to the session emphasized the importance of exchanging information and experience (training, best practices) first on a regional, but also on a global scale. In the discussion, there were further calls for increasing cooperation, especially in experience. There were calls for the regional and global information exchange to proceed through channels organized by the IAEA.

The discussion showed that most participants are familiar with the details of the international legal framework. A series of detailed questions on the interpretation of the international rules reflected this point. Other questions were posed to the USA and United Kingdom concerning the details of their international initiatives. For instance, M. Cojbasic, Serbia, asked how a country can join the Global Initiative to Combat Nuclear Terrorism (GICNT) and the answer was given that a letter must be sent to the co-chairs of the GICNT (Russian Federation and the USA) and the commitment to a statement of principles completed.

A major issue is that of raising awareness, as the scale of the problem is large. It was stated by S. Evans, United Kingdom, in response to a question from the Brazilian delegation about the actual cause of the problems and stopping points in international cooperation, that all delegates have a responsibility to keep their governments aware of the problem of illicit nuclear trafficking. It is essential that countries seek cooperation on all levels and in new areas.

The central result of the session is that, on the international level, the path to implementing a legal system that helps to combat nuclear terrorism is, for the most part, clear. States are at different points in the implementation process and, therefore, international support is needed for those who are at the start of their journey. The challenge for the IAEA could be to organize this support in the form of bilateral or multilateral networks which take cultural differences into account.

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Session 3: International Initiatives and National Efforts to Establish Capabilities

A.J. Al Khatibeh, Qatar

Presented by B.H. Weiss, Scientific Secretary

The theme of this session was the discussion of international initiatives to combat illicit nuclear trafficking and to view national efforts to strengthen capabilities in this regard.

United States of America

D. Huizenga, USA, presented his country's views on building alliances to combat nuclear smuggling. In his paper, D. Huizenga showed that extensive bilateral activity was ongoing to equip border crossings, airports and seaports with radiation detection equipment. He indicated that industry was responding to the challenge of combating nuclear smuggling and equipment was becoming very sensitive and maturing. D. Huizenga sees the challenge now as bringing together all the varying areas of expertise and authority to optimize efforts to address this serious threat. In his view, law enforcement, intelligence, and nuclear regulatory and nuclear security experts must come together with national and international organizations to be successful.

Russian Federation

V.I. Prostakov, Russian Federation, indicated in his paper on Rosatom's practice of prevention of unauthorized handling of nuclear and other radioactive material that the nuclear industry had produced hundreds of tonnes of nuclear weapons grade material and thousands of tonnes of radioactive waste. However, V.I. Prostakov believed that weapons grade material was well protected and accurately accounted for. In his view, the major threat comes from radiation dispersal devices, and he is sure that the Russian Federation realizes the gravity of this threat. V.I. Prostakov proposes the creation of an all State system, including all involved executive bodies of the Russian Federation (Rosatom being one the most important elements) to deal with this threat. V.I. Prostakov divided the activities of Rosatom with regard to the threat of illicit trafficking of nuclear material into two categories: the first is ensuring nuclear safety and security on site and during transport, and the second is providing technical support to technical bodies.

Ukraine

The Ukrainian efforts to combat illicit trafficking in nuclear and other radioactive material were presented by I. Kuzmyak. He described the legal basis of security of nuclear material: the law on the use of nuclear energy and radiation safety, the law on radioactive waste management and the law on the physical protection of nuclear facilities, nuclear material, radioactive waste and other radiation sources. In his paper, I. Kuzmyak described the system of accountancy and control used in the Ukraine. This system is based on the:

— State system of nuclear material accountancy and control;
— State register of radiation sources;
— State register for radioactive waste.

He went on to describe the three main methods of illicit trafficking prevention, namely, monitoring of possible transport inside the country or on the borders, investigations of law enforcement agencies and territory inspections. I. Kuzmyak also described the export control system and the comprehensive network of radiation monitors.

Sweden

The Swedish–Russian cooperation to prevent and detect trafficking on the Kola Peninsula, Russian Federation, was presented by L. van Dassen. He described the work done in improving nuclear security in the Russian Federation, physical protection being the highest priority. L. van Dassen indicated that the outcome of the cooperation was documented in a report. The report identified two major concerns: first, the complicated and inadequate legal basis at the federal and regional levels for combating organized crime and, second, the insufficient coordination among the various organizations within the country. On the basis of these findings, the Swedish Nuclear Power Inspectorate, according to L. van Dassen, initiated action to resolve these problems. L. van Dassen concluded by indicating that the problem of illicit trafficking in the Kola Peninsula was real, the federal and regional legislation is complex and contradictory, many nuclear facilities lack sufficient security measures, and cooperation between authorities is inadequate. Finally, L. van Dassen invited other donor countries and experts to join in improving the security situation.

Malaysia

The experience of implementation and improving import/export control for nuclear and radioactive material in Malaysia was presented by S.Y. Mohd. It was clear from this presentation that Malaysia was seriously considering combating illicit trafficking of radioactive and other nuclear material. It is doing so through enforcing Act 304 and its regulations, having import/export procedures, conducting inspections and spot checks. The country implements an effective response system by introducing a safety and security culture. The national strategy is fulfilled by drafting (and repealing) new nuclear laws, coordination with relevant agencies and development of an inventory of radioactive material. Malaysia has developed the integrated national detection system for nuclear and radioactive material. S.Y. Mohd described how Malaysia applies the Guidance of the IAEA Code of Conduct as a condition of licence.

Slovakia

Slovakia's efforts to combat illicit trafficking of nuclear material were presented by J. Vaclav. He described the system of measures to prevent the removal of material into illegal use, while retaining effective legitimate use of nuclear and other radioactive material. The aspects of the system are: prevention, physical protection, legislation, suppression and detection. J. Vaclav then outlined the cooperation between all concerned State institutions and cooperation with international organizations, such as INTERPOL and the IAEA. J. Vaclav concluded that illicit trafficking of nuclear and other radioactive material is an international crime and thus requires international cooperation.

Azerbaijan

The role of scientific institutions in combating illicit trafficking of nuclear material in Azerbaijan was presented by G.I. Akram. In his paper, G.I. Akram described the burden laid on the country due to sharing borders with nuclear countries. G.I. Akram discussed the relations between national institutions and their cooperation with other national and international organizations (e.g. the IAEA, NATO, the Turkish Atomic Energy Authority). G.I. Akram emphasized the need to improve these institutions in terms of equipment and training.

Kazakhstan

A. Kim gave an overview of the problem of illicit trafficking and its solutions in Kazakhstan. A. Kim listed the objective and subjective factors concerning illicit trafficking. The most important of these factors was the high commercial demand (for the purpose of resale at high prices) and the interest of international terrorist organizations/groups to obtain these materials for malevolent use. A. Kim went on to give some statistics for illicit trafficking. He concluded by proposing a solution to the problem in Kazakhstan based on amending the existing legal base, creating State nuclear security regulations, and better cooperation and coordination of the concerned parties in the country.

Poland

J. Niewodniczański presented the Polish experience in border monitoring. In his description of the legal framework, he indicated that all matters related to safety, security and emergency response were assigned by law to a single authority, namely, the National Atomic Energy Agency. J. Niewodniczański went on to describe the border monitoring network and the expected relocation of equipment when Poland enters the Schengen system next year. The statistics provided at the end of the paper indicated a large number of interventions starting from 1997 through 2006, with a maximum of 19 559 incidents in 2003.

Bangladesh

G.M. Solaiman discussed the problems of illicit trafficking in Asia and ways to prevent it. In his paper, which was based on open source literature, he attributed the increase in illicit trafficking incidents to three factors: the number of nuclear weapon States, the high number of terrorist and non-State groups seeking nuclear or other radioactive material in the region and the number of countries seeking to develop nuclear weapons programmes. G.M. Solaiman listed the alleged routes for the trafficking of nuclear material. He concluded with suggested ways of combating this phenomenon based on better coordination and dissemination of information at both the national and regional levels.

Conclusions and recommendations from the discussions

The following conclusions and recommendations resulted from the discussions:

- There are extensive efforts being made to build national capabilities to combat illicit trafficking of nuclear materials;
- Bilateral and multilateral initiatives are bearing fruits and must be encouraged (e.g. the Swedish–Russian cooperation and the US Second Line of Defense initiative);
- The presence of a strong legal basis is extremely important in combating unauthorized handling and illicit trafficking of nuclear materials;
- Cooperation among all the stakeholders (i.e. intelligence, law enforcement, customs and nuclear regulatory authorities) is vital at the national, regional and international levels if we are to succeed in our mission to combat nuclear smuggling.

Recommendations for actions by the international community

Recommendations for actions by the international community include the following:

- Whereas a lot of work has been and continues to be done at the national level, subregional, regional and international cooperation needs to be improved considerably;
- The international community may consider holding a regional seminar or workshop for the sole purpose of promoting regional cooperation and discussing pathways for the exchange of nuclear security information, with an emphasis on information related to illicit trafficking;
- The international community may consider launching a 'model project' for upgrading nuclear security infrastructure in certain States, with emphasis on legal frameworks/bases and technical capabilities. The experience gained from the radiation protection model projects may be utilized;
- In order for the IAEA to be able to perform its functions regarding international nuclear security, Member States and donor organizations should contribute to the Nuclear Security Fund.

Key issues and lessons learnt to be considered at the conclusion of the conference

Below are listed the key issues and lessons learnt to be considered at the conclusion of the conference:

— There was general agreement that illicit trafficking is a global problem and should be dealt with through global cooperation;
— The international community may consider prioritization of certain States for establishing legal bases to deal with nuclear smuggling;
— While there has been a significant improvement on the equipment and technical side, the response and forensics aspects need improvement in many States.

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Session 4: Establishing Capabilities to Detect Illicit Trafficking — II and II

N. Evans, Canada

It was clear from the session that while a tremendous amount of work has been done to help prevent the illicit trafficking of nuclear material, much work remains to be done. The papers can be viewed as providing a collection of national experiences that can be used to inform not only national architectures for the prevention of illicit nuclear trafficking, but can also be rolled up into regional and international frameworks.

A key element in developing a comprehensive strategy to prevent illicit nuclear trafficking is coordination: inter-agency within a country, interjurisdictional within countries, as well as regional and international cooperation in a variety of jurisdictions. For example, during the 2007 Pan-American Games, security was increased at nuclear facilities to prevent theft, and medical clinics issued certificates to those having undergone radiological treatments to help identify innocent alarms. In the USA, some municipal police forces wear personal detectors as part of a wider detection network. In Hungary, portal monitors have been installed at scrap yards. It is critical to ensure that there are established pathways, as well as a legal foundation, to facilitate coordination.

While national authorities are facing some distinct and unique challenges, a universal challenge is striking the appropriate balance between ensuring security and facilitating commerce by minimizing innocent and nuisance alarms, while maintaining a rigorous threshold for radiation detection. The two most widespread solutions are adopting a risk based approach to eliminate the screening of unlikely security threats, and using a phased approach in which screened loads pass through graduated 'yes' or 'no' levels which determine whether more rigorous screening is required. It is imperative that screening is not cumbersome, as the potential to interfere with commerce and to engender frustration among screening staff is ever present. It was also noted that it is essential to begin planning as early as possible.

Illicit nuclear traffickers can be clever and highly adaptive. As we develop bigger and better shields, the traffickers develop bigger and better swords to defeat our shields. For example, traffickers may use low category radioactive material to mask special nuclear materials. In order to defeat them, we must be innovative. During screenings, various techniques should be applied (new technologies to defeat shielding, handheld detectors, X rays, manifestos) and information should be triangulated as much as possible. Screening should take place not only at fixed border points, but mobile and relocatable screening units should also be deployed.

The discussion provided clarification of a number of issues, including that while many countries screen imports, an equal amount do not screen exports. This speaks to an approach founded in notions of national security, rather than global security, and should perhaps be revisited. It was also noted that countries that are in the early stages of developing an architecture to prevent illicit trafficking face particular challenges. Lastly, the importance of regional and subregional cooperation was highlighted.

Based on the session, I would respectfully offer two suggestions for the international community as part of the path forward:

(a) In order to save valuable time and resources, measures should be put in place to allow us to build on previous experiences. Many countries have built up significant databases on NORM. We should consider developing a mechanism for an international NORM database that incorporates multiple national databases. By amalgamating databases, the data drawn would be significantly larger and could help minimize 'noise' and allow screeners to identify NORM more quickly and efficiently. This would be especially useful for States that are in the process of developing screening programmes;

(b) There are a variety of methods and approaches being employed, and different countries and regions are at different points in the development of national and regional frameworks. The production of guidance documents by leading international agencies relating to the development of such national and regional architectures would be immensely useful. The guidance documents could include descriptions of phased screening, screening techniques, recommendations on inter-agency and interjurisdictional coordination, and time lines for planning.

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Session 5: Responses to the Detection of Criminal or Unauthorized Movement of Radioactive Material

L. van Dassen, Sweden

Presented by C. Price

There were ten presentations in the session that all addressed issues of:

— How the forensic and law enforcement responses were carried out in specific cases;
— How general measures and preparedness systems are in use by States and international organizations and bodies;
— What we can learn and not learn from specific cases in terms of response and responsiveness;
— The importance of operating good and reliable information and media strategies integral to of other response measures.

To the extent the overall content of the papers reflects general tendencies, there is reason to be optimistic about developments. At the level of States, the papers on response cases made it obvious that there are well established routines and an encompassing awareness when it comes to detection, forensic analyses and prosecution. Some States with fewer available resources seem to be having a harder time to develop the necessary legislation and have the proper analytical measures and preparedness systems in place. To the extent presented, it is obvious that States have national response systems. These national response plans are mentioned implicitly. A couple of years ago, it was different as there would be much focus placed on presenting the national response plans. In other words, it has become standard that there are solid systems of preparedness and response.

Where a State does not have sufficient expertise and infrastructure to carry out forensic analysis, it seems to be possible to cooperate with other States. The European Union operates capacities that can be made use of by others. Laboratories in the USA, the Russian Federation and other countries also have such capacities. This underlines the urgency that States associate with illicit trafficking. There are further mechanisms at play that make it possible to make forensics capacities accessible to more States. The IAEA operates mechanisms for detection and for assisting Member States and particularly developing States. This is a fact that is important and one which needs further support so that mobile expert support teams (MESTs) can reach all regions and countries in a reasonable time. Moreover, the International Technical Working Group provides an informal community for national experts and, in this manner, assistance as concerns forensics can be provided quickly when and where needed. On the other hand, it has to be mentioned that certain cases of smuggling, such as the ones mentioned for Georgia in 2003 and 2006, indicate that States assisting with regard to forensic analyses do not cooperate as well as would be necessary to fully disclose the many dimensions and threats related to the cases.

One issue which needs to be lifted out and treated separately concerns the information and public information functions of public authorities. The presented case from Germany revealed what a delicate issue it is to inform in the right manner and reassure the public. So far, we are only starting to understand and develop this dimension of our response in our field. Just to underline the importance of the issue, it can be illustrative to mention that what chemical, biological, radiological and nuclear (CBRN) terrorists would want as a primary or secondary effect is to create mass panic. We should not give terrorists any advantage just because responders do not have a thought through media and communication preparedness.

To paint with a broad brush, it can be stated that we are good in the technical and physical realms such as nuclear forensics. It also seems to be the case that national procedures in response situations are well managed. With respect to work that cuts across borders and concerns inter-State cooperation, much is being done at a formal and informal level. However, a great deal still needs to be done to ensure cooperation and a full use of response measures. When it comes to the management of information and communication issues, there are probably large issues ahead of us that need to be dealt with. However, if we can have a learning curve in the communication field that is as good as the ones we can identify in the other sub-areas of nuclear/radioactive responses, then we will move quickly even in this area.

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Session 6: International Initiatives and National Efforts to Establish Capabilities

C. Stoiber, United States of America

SUMMARY

The ten papers presented at this session reflected a broad spectrum of perspectives: geographical, organizational and professional. Eight of the presentations described the experience of national governments in their efforts to combat illicit nuclear trafficking. These included: Serbia and Croatia (Balkan region of Europe); Paraguay (Latin America); the Democratic Republic of the Congo (Africa); Lebanon (Middle East); Afghanistan (north-west Asia); the USA (North America); and Indonesia (south-east Asia–Pacific). Two presentations reflecting a multi-country approach were made by representatives of the International Science and Technology Centre (ISTC) in the Russian Federation and the Joint Research Center (JRC) of the European Commission. Notwithstanding this diversity, a number of common issues, themes and approaches were identified.

CONCLUSIONS

The threat of illicit trafficking in nuclear and other radioactive material poses serious challenges for governmental organizations, users of nuclear technology and society in all regions of the world.

Although most States have recently adopted enhanced measures to address illicit trafficking, further sustained efforts will be necessary to meet this threat in the future.

Many States, particularly those in regions of political instability or with underdeveloped economies, are experiencing difficulties in establishing national capabilities to mount an effective response to illicit trafficking. In general, these difficulties can be traced to a basic lack of resources — human, technical and financial. Specifically, the following difficulties were emphasized:

— Lack of sufficient trained personnel with adequate technical competence;
— Lack of equipment for the detection of radioactive materials at borders and for prompt and accurate analysis of detected materials;

— Reluctance of some customs or border officers to fully utilize detection equipment because of perceptions that it is too complicated or places too many demands on personnel;
— Inadequate legal or regulatory frameworks;
— Weak enforcement or sanction measures;
— Poor coordination among relevant national agencies and organizations;
— Lack of awareness of the threat by officials, users, the public and other stakeholders;
— Inadequate procedures for sharing information concerning threats or incidents;
— Inadequate nuclear forensics capabilities;
— Lack of adequate plans for incident response and crisis management;
— Inadequate arrangements for regional coordination and cooperation;
— Duplication or confusion in the provision of assistance by various donors and assistance organizations.

RECOMMENDATIONS

(a) Relevant international bodies and States in a position to offer assistance should continue and, where feasible, expand cooperation and assistance to States in enhancing their capabilities to combat illicit trafficking. In particular, emphasis should be placed on:
  (i) Training of relevant personnel, including customs officers, border guards and regulatory officials, in technical and administrative aspects of prevention, detection and response to illicit trafficking;
  (ii) Provision of equipment for the detection of radioactive materials, especially for border monitoring;
  (iii) Support for efforts to enhance national legal and regulatory frameworks through the adoption or revision of legislation and necessary implementing regulations;
  (iv) Support for measures to enhance law enforcement capabilities to address illicit trafficking, including nuclear forensics;
  (v) Activities designed to enhance awareness of the illicit trafficking threat by officials, exporters and importers, users of nuclear technology, the public and other stakeholders;
  (vi) Maintaining and enhancing measures for sharing of information, including electronic databases. In particular, more work should be done with the Illicit Trafficking Database to make it more useful for its diverse users;

(vii) Donor States and assistance organizations should make greater efforts to integrate their efforts through pooling of assistance teams and other measures to make these activities more efficient, cost effective and consistent;

(viii) Events such as this conference should be conducted on a regular basis to permit responsible persons and organizations to meet for the purpose of sharing experience and gaining information on relevant trends and technologies for combating illicit trafficking.

(b) All States should review and assess their capabilities to address the threat of illicit trafficking and implement measures to remedy weaknesses that may be identified. In particular, such measures should include:

(i) Adopting or revising national legislation and implementing regulations to address illicit trafficking in a manner consistent with relevant international instruments and guidance documents;

(ii) Devoting adequate human, technical and financial resources to national bodies responsible for addressing illicit trafficking;

(iii) Establishing effective programmes for recruitment, training and support of personnel responsible for addressing illicit trafficking;

(iv) Increasing awareness of the illicit trafficking threat by officials, exporters and importers, users of nuclear technology, the public and other stakeholders;

(v) Adopting mechanisms for coordination among all organizations that may have responsibilities relevant to addressing illicit trafficking, including sharing of information;

(vi) Establishing and periodically exercising plans for responding to incidents of illicit trafficking, including, where practicable, plans for coordinating with neighbouring States and international and regional organizations;

(vii) Strengthening regional cooperation to make better use of limited resources and to coordinate efforts by neighbouring States.

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Session 7: New Technologies

P. Thompson, United Kingdom

The session was an extremely interesting collection of eight papers dedicated to improving current technologies, standardizing equipment and testing methods, and offered tantalizing glimpses into the technologies that should be available in the future. The contributors are to be congratulated on their contributions to the conference. The point was made that the cost of deterrence is much less than the cost of rehabilitation if a nuclear related incident occurs.

One of the recurring themes of the papers presented was how technology has been improved over the last ten years both by research and development on the technology of the instruments themselves and by paying greater attention to the development of standards and testing procedures for the instruments. A further spur has been the definition of the requirements that the instruments are required to meet as the problems faced by the world have been identified.

A second theme was the many joint programmes between countries and international organizations to minimize wasteful duplication of effort and to lead to worldwide acceptance of the specifications and instrumentation that have been developed. These efforts have led to the development of standards for the equipment currently being deployed. These standards developed by ANSI, IEC and the IAEA have led to a better match between the equipment specifications and operational requirements. Testing procedures have been developed to allow confidence that equipment delivered matches its quoted specifications, although equipment rejections on technical and quality grounds remain higher than is desirable.

A vital contribution has been the identification of capability gaps, to which resources have been directed, so that if they have not been closed yet there are at least plans to address the gaps. Great efforts are being made for the detection of shielded HEU as reported in the talks on active neutron interrogation and muon detection. The need has been seen to develop portal monitors that have the capability to identify the nuclides detected to allow quicker release when the detected isotopes are NORM, and to detect materials illicitly co-shipped with legal material. An area of great progress has been in the development of handheld radionuclide identification detectors, both in the technical capabilities of the equipment and in the spectral libraries of the nuclides pre-loaded. Similarly, handheld neutron detectors have been developed. The nuclear industry has been researching the use of muons to find fissile material held up in plants. The potential for using the technology to find concealed fissile material to monitor illicit trafficking was discussed. The talk generated great interest in the audience and provoked several questions relating to the progress made in detecting material and the state of the project. The proposed protocols to efficiently find, identify and locate radioactive/fissile material using a single detector advanced spectrometric panel shows how the current capabilities can be developed to reduce the number of and time delays caused by NORM with the minimum of new and diverse equipment.

With the large number of radiation detection assets that are currently available for deployment in response to incidents, the importance of all the available information being available to control centres and expert interpretation was highlighted. The ability to network all measurements, ranging from personal monitors to portal monitors, to the control centre is a valuable contribution to command and control. The capabilities of a system using a DD pulsed neutron source for active interrogation of fissile material were highlighted with regard to its advantages of no radioactive material present in the device, the large size of sample that could be examined and its high efficiency, especially when used in conjunction with digital signal processing. The development of digital signal processing to allow processing of high count rate signals and the differentiation of neutron and photon signals to allow active interrogation by DD generated neutrons of fissile material in baggage was reported. Of special interest was the ability to measure fissile material that was shielded by materials with a high thermal neutron absorption cross-section.

The overall impression from the session was that there has been great progress over the past ten years in increasing global capabilities, both as regards the deployment of equipment worldwide and its capabilities. The progress made in international cooperation to close capability gaps and prevent effort duplication is to be welcomed.

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Poster Sessions

Rapporteur: M. Mayorov, IAEA

There were 22 poster papers focused around three groups of topics:

(a) Status of national nuclear security systems: approaches, achievements and the future;
(b) International efforts to combat illicit nuclear trafficking;
(c) New technologies for nuclear security application.

In the first group of posters, the positive experience in building national capacity to counteract nuclear trafficking in Albania, Bangladesh, Germany, Indonesia, Lithuania, Nigeria, Norway, Pakistan, Paraguay, Poland, the Russian Federation, Serbia, Thailand and Uzbekistan were presented.

Although the status of the national implementation of nuclear security systems varies from the very initial stage to relatively well established, it is worth noting that there is a high level of nuclear security awareness in the international community.

The second group of posters directed their attention to the role of international initiatives to build an effective, efficient and sustainable system to counteract illicit trafficking. The importance of cooperation between Member States and international organizations, the comprehensive evaluation of the nuclear and radiological threat, and the assessment of the efficiency of the implemented nuclear security measures were emphasized. It was suggested not to limit the overall efforts to combat illicit trafficking to SNM only, but rather to consider additional radiological threats involving large area contamination with hardly detectable alpha emitters (such as ^{210}Po). Further practical steps, following the commitment to United Nations Security Council Resolution 1540, were suggested to be the logical follow-up of resolution implementation.

This second group also included a report on the continued efforts in the area of human resource development. In cooperation with the IAEA and other international organizations, a comprehensive nuclear security training programme exists to address the many facets of human resource development.

The third group of posters was dedicated to the new instrumentation and methodology to combat illicit nuclear trafficking. The emphasis in this section centred on concern for the improvement of the illicit trafficking detection algorithm (a complete methodology that incorporates many factors, such as funding, training and staffing), a new technique of isotopic composition analysis for nuclear forensics, recently developed instruments for detection, localization and identification of nuclear and other radioactive material, and recommendations concerning specifications for the new type of radiation detection equipment utilized in nuclear security applications.

RECOMMENDATIONS FOR ACTION BY THE INTERNATIONAL COMMUNITY

The following recommendations were considered important for action by the international community:

— Consider different scenarios of the radiological and nuclear threat, not limited by risk of malicious use of a weapon of mass destruction;
— Improve understanding about patterns and trends in illicit nuclear trafficking;
— Examine the performance and efficiency of the implemented radiation detection equipment and to foster an exchange of information on new detection technologies and response methodologies;
— Strengthen communication networks and international cooperation to share relevant information;
— Continue efforts on the improvement of radiation detection equipment to meet end-user requirements through the conduct of relevant research and development programmes;
— Implement further practical steps, following the commitments of Member States within the scope of United Nations Security Council Resolution 1540.

CONCLUDING SESSION

PRESIDENT'S FINDINGS

P. Jenkins

1. INTRODUCTION

The conference was convened to take stock of achievements in recent years, challenges in addressing the need to combat illicit nuclear trafficking and avenues for future action. Particular attention was paid to where further actions of individual States and cooperative international actions might usefully be initiated. The conference was hosted by the United Kingdom Government and organized by the IAEA in cooperation with INTERPOL, Europol and the World Customs Organization (WCO). Attendance by approximately 300 participants from some 60 States and 11 international organizations was testimony to the widespread recognition of the importance of the issue.

2. ILLICIT TRAFFICKING AND NUCLEAR TERRORISM

The IAEA Illicit Trafficking Database (ITDB) was set up in 1995 to collect information on incidents of illicit trafficking and other unauthorized activities involving nuclear and radioactive material. Presently, 99 States participate, on a voluntary basis, in the programme. The ITDB, which is an authoritative, central, international source, provides evidence of persistent illicit nuclear trafficking, thefts and losses, and other unauthorized activities involving nuclear and other radioactive materials. There was broad consensus that terrorist groups have the intention of attempting to acquire and use nuclear or radioactive material for malicious acts. The conference recognized that the ITDB provides valuable information both on such attempts and on weaknesses and vulnerabilities which may be exploited to acquire the material.

The conference stressed that stopping the illicit movement of nuclear material, equipment and technologies that could be used for malicious purposes continues to be a global priority. Since the human, political and economic consequences of a successful malicious act involving nuclear or other radioactive materials could be far reaching, the limited knowledge of direct attempts to acquire such material is no cause for comfort. The conference recognized that a holistic approach, addressing both detection and prevention, is essential. There was wide agreement among the conference participants on the value of the ITDB and encouragement for further expansion of the comprehensiveness and quality of the information and its analysis with a view to further enhancing understanding of illicit nuclear trafficking.

3. INTERNATIONAL BINDING AND NON-BINDING INSTRUMENTS* AND THEIR IMPLEMENTATION

The conference noted the emergence of new and amended international instruments related to nuclear security, which require States to strengthen measures to combat illicit trafficking. Taken together, the provisions of these instruments, some binding, some voluntary, amount to a significant strengthening of the legal and guidance framework existing prior to 2001. The framework includes IAEA Safeguards Agreements and their Additional Protocols, inasmuch as these require accounting and control of nuclear material and the establishment of State systems of accounting and control. The conference saw a need to continue building the institutional framework that is necessary to implement these legal instruments, in particular by establishing the required technical and administrative systems. In that respect, model elements for a national legal framework to deal with illicit nuclear trafficking and IAEA assistance can play a useful role. The conference recognized that universal adherence to the amendment to the CPPNM and other international legal instruments will make a major contribution to enhancing nuclear security and combating illicit trafficking. The conference noted suggestions that consideration be given to strengthening legally binding obligations in relation to the safety and security of radioactive sources.

4. INTERNATIONAL COOPERATION

The conference took note of the contribution made by initiatives such as the global initiative on combating nuclear terrorism and the European Union strategy against the spread of weapons of mass destruction, as well as by organizations such as Europol, INTERPOL, WCO, the International Civil

* Convention on the Physical Protection of Nuclear Material (CPPNM) and the Amendments to the CPPNM, International Convention for the Suppression of Acts of Nuclear Terrorism, United Nations Security Council Resolutions 1373 and 1540, Code of Conduct on the Safety and Security of Radioactive Sources, the supplementary Guidance on the Import and Export of Radioactive Sources, and Safeguards Agreements and Additional Protocols.

Aviation Organization (ICAO) and the United Nations Office on Drugs and Crime (UNODC). The conference also noted positive developments in cooperation between these organizations and the IAEA, and encouraged further efforts in this direction. The obligation, included in legally binding international instruments, for States and the IAEA to interact on the recovery and return of stolen or seized nuclear and other radioactive materials was recognized.

The conference stressed that international cooperation is essential for the understanding of trafficking circumstances, patterns and trends, and that continued efforts are required to strengthen existing networks, such as the IAEA ITDB point of contact system. The conference welcomed recent progress in the development of radiation detection instruments and that international interaction, including through coordinated research and development, has contributed significantly to those achievements. The conference encouraged continued and strengthened mechanisms to facilitate the development of new technologies and strategies, in particular for the detection of fissile materials, noting that the private sector can play an important role in technology development.

The conference heard of significant advances in nuclear forensics technologies which can be used to trace and preserve evidence related to seized radioactive materials and which permit ever more accurate identification of the origin of interdicted material. The conference hoped that these capabilities would be put at the disposal of States that do not have access to them and that more would be done to expand and improve reference data necessary for nuclear forensics to achieve its full potential.

5. REGIONAL COOPERATION

The conference stressed the benefits that can accrue from strengthening cooperation at the regional level, especially in the areas of detection and response. It took note of some encouraging developments in this regard.

6. NATIONAL EFFORTS TO ESTABLISH DETECTION AND INTERDICTION CAPABILITIES

States are increasingly recognizing their responsibility for controlling unauthorized movement of nuclear and other radioactive material. Efforts have been made to secure national borders through the installation of radiation detection equipment and to ensure that law enforcement officers have adequate training, skills and support to detect unauthorized radioactive materials, and to respond to seizures and detection alarms. Recent years have seen dramatic improvements in equipment and methodologies for detecting and characterizing illicitly trafficked material.

Many States reported on their national efforts to enhance measures to combat illicit trafficking, demonstrating a widespread awareness of the problem. The conference welcomed reports about advanced capabilities being deployed in many States. However, there were also indications of significant disparities between capabilities in different States. The conference recognized that some States need continued assistance from the IAEA and other donors. The conference was encouraged by indications of enhanced cooperation within States between relevant organizations with responsibilities for different aspects of combating illicit trafficking.

The conference noted that there was a need for increased sophistication in strategies for deploying and implementing detection capabilities which take into account all aspects of the risk, including that posed by unguarded borders. In particular, the hosting of major public events would call for assurance that radioactive material could not be used in a malicious way to disrupt the event.

The conference emphasized the importance of States developing strategies to ensure the sustainability of national prevention and detection systems, and their scientific and technical support. In that respect, it recognized the function of nuclear security support centres. The conference recognized the importance of formulating effective communication strategies to avoid adverse public reactions to nuclear or radiological incidents.

7. ROLE OF THE IAEA

The conference acknowledged with appreciation the overarching goal of the IAEA's Nuclear Security Plan for 2006–2009 (plan) to strengthen nuclear security worldwide. A key objective of the plan is the development of an internationally accepted nuclear security framework, in which IAEA guidance complements the binding and non-binding legal instruments with recommendations and guides on their implementation, to be published in the IAEA Nuclear Security Series. The conference supported the key function of the IAEA in the development of an internationally accepted nuclear security framework.

The conference encouraged the IAEA to play a central role in the exchange of information, notably between IT databases, and to strengthen the ITDB point of contact system. It also saw a need for effective analytical capacities and strengthened interaction between international organizations, within their mandates, for that purpose.

The conference welcomed IAEA services and assistance, for example, with the assessment and evaluation of existing systems, technical advice related to improvements, human resource development programmes and — to a limited extent — the technical equipment that is required for improved security. The conference also welcomed efforts to make available nuclear security support centres.

The conference recognized with appreciation the contribution made by bilateral assistance programmes in the establishment of technical systems to prevent and detect unauthorized movement of nuclear and other radioactive materials. It encouraged effective coordination by the IAEA to ensure complementarity and efficient use of resources, and recognized that IAEA integrated nuclear security support plans, as established for individual countries, could be a useful tool for that purpose.

The conference encouraged the IAEA's central role in promoting and coordinating research and development in the field of detection and response to illicit nuclear trafficking as part of effective nuclear security systems. The conference recommended that the IAEA convene a further conference on illicit nuclear trafficking in 2010 to assess progress.

The conference concluded that as illicit nuclear trafficking remains an international concern, with potential for serious consequences for human life, health, property and the environment, efforts must continue to establish effective systems — technical and administrative — to control the movement of nuclear and other radioactive materials, and to prevent and detect their uncontrolled and unauthorized movement.

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Illicit nuclear trafficking remains an international concern, with repercussions for human life, health, property and the environment. This publication presents the proceedings of the first international conference to specifically address illicit trafficking of nuclear and radioactive material. The principal aims of the conference were to examine the threat and context of such trafficking, to assess the results of activities in place to combat it, and to consider what additional actions are needed. In addition, discussion focused on how obligations and commitments of binding and non-binding international instruments could be and are being implemented by various States. This volume includes a summary of the conference, the presented papers, and the findings of the conference by the President, as well as the conference discussions. The presentations and the complete text of the printed volume are provided on the CD-ROM which accompanies this publication.

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